The Royal Aeronautical Society

(FOUNDED 1866)

with which is incorporated The Institution of Aeronautical Engineers

No. 228. DECEMBER, 1929. Vol. XXXIII.

PROCEEDINGS

TWELFTH MEETING, SECOND HALF, 64TH SESSION

In the Chair:

THE PRESIDENT, COLONEL THE MASTER OF SEMPILL

The Twelfth Meeting of the Royal Aeronautical Society was held in the Lecture Theatre of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C.2, on Thursday, May 23rd, 1929.

The PRESIDENT: Mr. Foord had been engaged in the Engine Department of the Air Ministry since it was formed, and was responsible for air-cooled aircraft engine design, and for fuels and oils. Before going to the Air Ministry he had served in the department of the Engineer-in-Chief at the Admiralty. His paper was an extremely important one to aero engine designers and, in fact, to all users of aircraft.

THE LUBRICATION OF AIRCRAFT ENGINES

BY

F. A. FOORD, A.F.R.AE.S.

Mr. FOORD: It has been truly said that "lubrication is the heart of an engine," and I think this saying applies in the strongest possible sense to aircraft engines.

The reasons for this are manifold and one has only to consider the overall thermal efficiency, the low weight/power ratio and consequent minimum scantlings and bearing surfaces, and the high working temperatures of this class of prime mover compared with other types, to realise that the duty the lubricant has to perform is far and away more severe than is the general case.

If one takes into consideration all the various properties which the aircraft engine designer demands for the lubricant, it must be recognised that from an ideal point of view, there is no really satisfactory lubricant for the work and that the only thing that can be done in order to give the best all round results is to effect a compromise.

It is quite obvious that in order to achieve success, the closest co-operation between the aircraft engine designer and the oil technologist is necessary and that each should try to appreciate the other fellow's problems—that way will undoubtedly result in the best compromise and give efficiency.

In the past there has been a great tendency for the engine designer, absorbed as he is in his own knotty problems, to produce a design and then say to the oil technologist—give me an oil to do the job; but I am glad to say that this system of things is now altering rapidly.

There are many features in detailed design which, if given consideration in the early stages and with a knowledge of the oil producer's difficulties, would give considerably improved results.

There is no room for "rule of thumb" methods and this applies equally to the oil technologist, who I am glad to say is rapidly improving his refining methods and giving the aircraft industry greatly improved oils. This fact is undoubtedly a contributory factor to the increased reliability of aircraft engines which is being demonstrated to us every day.

There is a limit, however, to this improvement in the quality of lubricants as we are confronted with the limitations of natural products.

Unfortunately, the only really satisfactory method of determining the suitability of a lubricant is by extended endurance tests on the type of engine concerned, and when one realises that to run a 400 b.h.p. aircraft engine on the test bench costs something like £10 per hour, and that nothing less than a hundred hours' endurance test is really satisfactory, it will be appreciated that this method of selecting suitable lubricants is rather costly.

In addition, each distinct type of aircraft engine appears to have a soul of its own as regards lubrication—due probably to the widely varying mechanical features.

In considering the problem, therefore, of provisioning lubricants for a body like the Royal Air Force, and this applies equally to any other large body or commercial undertaking, where the classes of engines and corresponding duties are widely divergent and where it is necessary to keep the types and grades of lubricant down to an absolute minimum, a bigger compromise than ever is necessary.

In addition, in the case of Government departments, a kindly Treasury lays down a rule that everything shall be purchased to a specification by competitive tender.

Drawing up specifications for lubricating oils is a thankless task and the man has yet to be found who can devise the ideal specification, which will ensure that by tests in the laboratory he can select the most suitable lubricants and also obtain absolutely concordant results when used in the engine.

The final arbiter, of course, of the suitability of the lubricant is the endurance test; but in view of the necessity for specifications, it behoves us to consider seriously what are the ideal characteristics of a lubricant for aircraft engine work and how far we can get by laboratory methods to ensure that such characteristics are obtained.

Ideal Characteristics

The following characteristics are referred to roughly in their order of importance:—

Viscosity Temperature Curve

Viscosity is of primary importance from the point of view of the loading which any bearing can safely sustain at the temperature prevailing, without rupture of the oil film.

In the aircraft engine the conditions under which the lubricant has to perform its function differ considerably according to the part to be lubricated. The qualities required for the lubrication of the cylinders and pistons are not the same as those required for the lubrication of bearings, and yet we are forced to use the same lubricant for all the vital parts.

In this respect the aircraft engine differs fundamentally from other prime movers, *e.g.*, steam and gas engines, where it is possible to use different lubricants for different parts.

We have to select an oil capable of maintaining a lubricating film on the cylinder walls with temperatures prevailing round about 150° to 200°C. The same oil has to lubricate big-end bearings heavily loaded with temperatures of the order of 90°C.

In addition, we have to ensure a steady and ready flow of oil to all parts on starting up at temperatures round about 0°C.

The corollary is an oil that has the least possible change in viscosity with temperature over the entire temperature range.

It is desirable, of course, not to use an oil with a viscosity higher than is necessary for maintenance of the oil film, otherwise excessive friction and heating will result.

For this reason there is a school of thought which advocates low viscosity oils; but this involves high pumping capacity, increased consumption and a lower margin of safety as regards rupture of the oil film.

It is not considered that the adoption of such oils is practicable on aircraft engines at present, although of course further development work might prove their feasibility.

Generally speaking, in order to obtain the best viscosity temperature curve for all the conditions it is necessary to blend oils from different crudes.

There is one point to be taken into consideration in settling the viscosity of an oil for aircraft engines and that is the dilution factor which, although important in many other cases, is not very serious in aircraft engines. This is due to the high average crankcase temperature and the dry sump system of lubrication generally adopted, both of which tend to prohibit the retention in the oil of any petrol leakage past the piston rings. It is interesting to observe that oils in use in the Royal Air Force to-day have viscosities of about 90-100 seconds Redwood for summer work and 70-80 seconds Redwood for winter work, both these figures being taken at 200°F. (93°C.), and much the same figures apply to ordinary commercial aviation. The Redwood viscometer is normally used for commercial purposes, but where greater scientific accuracy is desired it is advisable to work in C.G.S. units.

Carbonisation

In many respects the most important feature of a good aircraft engine oil is that it shall leave the engine as clean as possible after endurance and that the deposits formed during the passage through the engine shall be of such a nature that they do not clog the oilways or build up in critical spots, *e.g.*, in crankpins and around piston rings.

There is no oil discovered which is free from this particular type of trouble and all that can be done is to minimise the waste products, partly by careful mechanical design and partly by choosing such oils as withstand the destructive distillation and oxidation processes which they have to undergo in the engine, for the longest period.

It is here that the laboratory is provided with what may be considered its most difficult problem, viz., to provide a test which will give some idea of the results in this respect which may be expected on engine endurance.

There have been many efforts to solve this problem and numerous well known tests are in existence which aim at giving the desired results.

In considering the changes which the lubricating oil is undergoing during its passage through the engine, it would appear that the bulk of the oil is being slowly oxidised by the heat in the presence of air, forming at first soluble asphalts, then insoluble asphalts, and finally a proportion which is in contact with the hot spots. *e.g.*, piston rings, crowns and combustion chamber walls is turned into carbon.

The character and quantity of this carbon differs with the various grades of oils utilised, and it should be the aim to select an oil in which this deposit is a minimum, and also the character of the deposit should be soft and flaky so that the bulk disappears with the exhaust.

In view of the foregoing considerations, what is required is an oil which has a minimum of non-volatile residue, *i.e.*, a small value in the coke number test is of importance.

The coke test adopted by the Air Ministry consists of introducing about 4 grams of the oil into a weighed glass bulb surrounded by an iron sheath, the whole being placed in a bath of molten metal maintained at a temperature of 550°C.

The oil is allowed to remain for ten minutes after fuming has ceased. The bulb is then re-weighed and the increase in weight expressed as a percentage of the original weight of oil is taken as the coke number.

This test gives a comparative idea of the coke-forming tendencies of the various oils in their original state, but what is more important is the tendency of the oil to coke after it has undergone the oxidation process which the engine imposes upon it.

It is quite possible to have two oils with low initial coke numbers, but after oxidation one might show a moderate increase whilst the other might show a large increase in coke number.

From experience of comparative engine endurance tests on such oils it would appear that the latter oil gives the dirtier engine, and the procedure of comparing coke numbers after subjecting the oil to an oxidation test has therefore been adopted.

This latter test consists of placing 40 c.cs. of oil in a boiling tube and fixing the tube in an oil bath, the temperature of which is maintained at 200°C. Air is then passed through the oil in the boiling tube at the rate of 15 litres per hour for two periods of six hours on consecutive days.

The viscosity of the blown oil is then determined at 100°F., and the ratio of this viscosity to the viscosity of the original oil at the same temperature is taken as a measure of the tendency of the oil to oxidise.

A figure of about 2 : 1 is an average for suitable oils.

The coke number of the blown sample of oil is then determined and compared with the coke number before blowing.

The figures adopted for the aircraft engine mineral oils are 0.65 and 1.65 respectively, and the oils which pass this test give very good results, but it is realised that such figures are somewhat restrictive in character from the supply point of view and tests have been in hand for some time to determine how far they can be relaxed.

Whilst discussing this question of oxidation and coke-forming tendencies there is one point of importance to be noted, and that is it is very desirable with mineral oils to select one in which the asphalt formed is as far as possible soluble in the main body of the oil, as it is the insoluble asphalts which result in the immediate production of carbon and also they have a great tendency to separate out and clog oilways.

I should like to say here that these particular tests are based on Dr. Ramsbottom's work at the Royal Aircraft Establishment.

Cold Test

In as far as winter operation is concerned and also, of course, due to the fact that aircraft engines are subjected to temperatures at altitudes far below that normally experienced by other prime movers, a good cold test oil is a necessity.

Temperatures at altitude of −45°C. are quite frequently experienced with fighting machines and exposed oil pipes are liable to give trouble.

In addition, aircraft are liable to be housed in temporary hangars under extreme climatic conditions entailing very low ground temperatures, and unless elaborate precautions are taken for keeping the engine and oil tanks warm the time for starting up is enormously increased and, in addition, the risk of doing damage to bearings and other vital parts is great owing to the time which is liable to elapse after starting before the oil circulates freely.

Generally speaking, the cold test difficulty is greater in the case of fatty oils than with mineral oils.

This is particularly the case with castor oils, which are so widely used in this country for aircraft engines.

Pure pharmaceutical castor has a great tendency to deposit solids, commonly known as "foots," if exposed to low temperatures for any length of time and this causes trouble due to blocking of filters, oilways, etc.

During the War this trouble led the castor oil firms to experiment with a view to delaying such deposition and the result was what is generally known as "treated castor."

It should be observed that the process is a proprietary one and originated with the Hull Oil Manufacturing Co.

To quote the standard specification for such oils, "By the term 'treated' castor oil is to be understood a pure castor oil treated by physical or chemical means in such a way as to delay its time of setting without appreciably diminishing its value as a lubricant."

The results obtained are very good and no freezing troubles have been experienced with such oils; but of course certain other characteristics of the castor oil are unavoidably changed in the process, *e.g.*, critical solution temperature in alcohol raised, viscosity and acidity increased.

These result in enhanced gumming propensity when used under hot climatic conditions, but even pure castor oil is not free from this trouble.

Another famous oil firm has obtained equivalent results as regards cold test by compounding castor oil with a small percentage of mineral oil, and this appears to give good all round results from the technical point of view.

The method adopted in the case of castor oils for determining the cold test is to previously warm a sample of the oil to 30°C. and allow to cool to ordinary temperature and then place in a test tube 18 mm. in diameter filled to a height of about 30 mm.

Seal the tube to exclude moisture and then expose to a temperature of −10°C. In the case of pure pharmaceutical castor the oil must remain perfectly clear for four days and treated castor for ten days, and no solid particles shall have separated out at the end of this period.

As regards cold tests for mineral oils, the method adopted for cold tests is a modified Schultz method. This is in effect a viscosity test at low temperatures and appears to most nearly reproduce the actual engine conditions for this class of oil.

The oil which has previously been kept at room temperature for 12 hours is introduced into a U tube of 6 to 7 mm. diameter and limbs 15 mm. apart to a depth of 10 cm. in each limb.

The tube is then heated to 80°C. in a water bath for five minutes after which it is placed in a freezing mixture at the specified temperature. After 20 minutes a pressure of air equal to a head of 12 in. of water is applied to one limb of the tube without removing the tube from the freezing mixture.

The rate of flow of oil under this pressure shall not be less than 1 cm. during the first minute.

The temperatures for summer and winter grade oils are 0°C. and −10°C. respectively.

Oiliness

This property of lubricating oils is one around which much discussion is centred, but which, so far, no one appears to have defined definitely.

The popular idea is that fatty oils have greater oiliness than mineral oils and to a certain extent this appears to be justified.

What does appear certain is that oiliness is a surface effect produced by the lubricant upon the metallic surface with which it comes in contact, and that fatty oils have this property of adherence and of lowering the friction under very severe conditions of heavy loading and slow speeds to a slightly greater extent than mineral oils.

With regard to aircraft engine conditions of lubrication, however, it would appear that there is no appreciable difference between the performance of the two types of oil of similar viscosity under the ordinary running conditions and that other factors which matter more have to be taken into consideration.

There are several very interesting methods in use in laboratories for comparing coefficients of friction and temperatures of seizing under corresponding loading conditions; but experience has shown that within limits these factors are not of primary importance in selecting an oil for the work under review. It is very rare in diagnosing failures of aircraft engines that one is confronted with a case of definite breakdown of the lubricating film which could be attributed to the nature of the oil itself.

Specific Gravity

This feature of an oil has little if any bearing on the lubricating properties, but is sometimes useful as an indication of the probable source of the oil.

In considering mineral oils of the same viscosity range, it is probably true that the high gravity asphaltic base oils have steeper viscosity temperature curves, better cold tests and result in higher carbon residues than the low gravity paraffin base oils; but this is by no means always the case and there are quite a number of exceptions to such a rule.

In addition, such high gravity oils do not generally have as high a dilution factor as the low gravity oils; but as previously discussed, this is of little importance in aircraft engines.

Flash and Fire Points

The flash point of an oil is chiefly of value as indicating the safety with which it can be handled; but with lubricating oils their flash points are generally so high that this particular point is not very important.

Nevertheless, with aircraft engines we have always the possibility of crashes and consequent fires which are very often started by the splashing of oils and fuels on to hot parts, such as exhaust manifolds, and in this respect a high flash point is an advantage.

In addition, high flash or fire point is of importance in connection with the sealing of pistons and rings, if the flash or fire point is too low the oil will ignite and burn, depositing carbon around the rings, thus causing them to lose their effectiveness as a seal.

Generally speaking, the flash point of an oil is valuable as a source identifying characteristic.

The open flash point of aircraft engine mineral oils is about 200°C.

Other Characteristics

There are quite a number of other tests frequently applied to lubricating oils, such as dilution factor, emulsion tests, sulphur test, colour test, corrosion test and evaporation test, but these are not of primary importance.

The first two lose their importance as far as aircraft engines are concerned because of the dry sump system of lubrication adopted.

The corrosion test is of interest in so far as it affects the condition of storage of engines and this is referred to later on.

Evaporation tests are sometimes applied as being indicative of the rate of oil consumption in an engine; but in the case of aircraft engines the efficiency of piston sealing and scraping and the viscosity of the oil are of greater importance than this.

Selection of Lubricant

From the first real attempt at a light weight aircraft engine, viz., the Gnome rotary in pre-war days, castor oil or a castor base oil has been used as the lubricant, and on the whole has carried out its functions in a most satisfactory manner.

The real reason for using castor oil in the case of the Gnome engine was the fact that the engine was of the rotary type and was therefore supplied with its fuel/air mixture in an atomised form through the crankcase on its way to the cylinders.

Mineral oils would have soon been dissolved in the fuel mixture and carried through with it to the cylinders, leaving the bearing surfaces in the engine dry and consequently unlubricated.

Castor oil is not subject to this trouble and was therefore utilised.

In addition, of course, the good viscosity at high temperatures and the comparative cleanliness of strip were both attractive, and consequently castor oils became standardised.

This has been perpetuated and to-day we are confronted with the fact that practically all British aircraft engines, and not a few Continental types, have been developed with castor oil as the basic lubricant, in fact it has become quite a fetish with the engine designers and the mere mention of alternative oils is quite sufficient to start a heated argument.

Whilst agreeing that there is a certain amount of justification for this attitude, it is considered that the time has now arrived to make a departure.

First and foremost, castor oil is relatively costly—approximately twice the cost of mineral oil.

Secondly, its supply is limited by the quantity and quality of the seed harvest, which is apt to be very variable and in times of emergency might fail us.

Thirdly, with the intense development of modern aircraft engines and the consequent high piston temperatures and speeds, the gumming factor with piston rings when fatty oils are used is of the utmost importance.

The mere fact that any aircraft engine is forced to use castor oil is a serious drawback to its universal use abroad, and cases have been known where this fact has been a deciding factor in the placing of an order for engines.

The rapid spread of civil aviation and institution of long distance air lines demands that aircraft engines shall not be so fastidious in their lubrication systems and that they should be able to function satisfactorily on local supplies in whatever part of the globe they may be.

In practically all cases this local supply is a mineral oil and it is significant that the U.S.A. and the Central Powers use practically nothing else for their engines.

Mineral oil has not been utilised in this country much up to the present, primarily because it has been considered that the bearing load factor is much less than with castor and also because of the generally dirty appearance of engines on strip after endurance.

This latter effect is largely psychological and is no real detriment except in so far as there may be a tendency to sludge and fill up lubricating oil grooves and holes.

Modern development in refining and blending methods, however, has produced mineral oils which go far to meet these objections, and recent tests have demonstrated fully that such oils are quite suitable for our latest types of engines and that no difference in wear or lubrication of vital parts is apparent when changing over from castor base oils.

Another important factor from the Service point of view is the question of deterioration of oils during storage and also the effect of the various oils on the storage of engines.

Castor base oils are prone to both troubles and in particular the high acidity of these oils is a drawback from the point of view of corrosion of important parts of engines in store, such as ball and roller bearings, particularly in the presence of moisture, which accentuates the trouble.

So serious is this difficulty in the Service that it has been found desirable to institute a special storage procedure to obviate such troubles.

This consists in making special arrangements to turn the engine when cold at about 200 r.p.m. for ten minutes with the oil pump suction connected to a tank containing lanolised or other approved mineral oil before storing and to repeat this procedure every six months. This ensures a protective coating over the whole of the inside of the engine.

The Royal Air Force at present standardises on four different types of lubricating oil, viz. :—

(*a*) Pure pharmaceutical castor.
(*b*) Treated pharmaceutical castor.
(*c*) Mineral oil, summer grade.
(*d*) Mineral oil, winter grade.

Every endeavour is being made to reduce this number to at least two standard oils, probably one summer grade and one winter grade oil, and it would be preferable if possible to have one universal oil; but it is recognised that this is difficult of fulfilment, primarily because of the difficulty of obtaining an oil with the necessary viscosity at high temperatures for summer work and the low setting point required for winter conditions.

During the first consideration of this problem it was thought that the only way of reducing the grades of oil to a minimum was to adopt a compounded type of oil and tests were made in this direction, particularly with oils composed mainly of a suitable mineral base and the rest fatty oil.

Further experience showed, however, that a good class mineral oil was quite capable of meeting all requirements.

Application to Engines

The principal features of aircraft engine lubrication systems may be briefly summed up as follows :—

A pressure feed system through the crankshaft to all main bearings, big-end bearings, reduction gears, camshafts and other auxiliary drives with generally splash to the gudgeon pins and pistons.

The details, of course, vary with each type of engine, and these will be referred to later on.

A dry sump system of lubrication is practically universal except for one or two of the low powered light aeroplane engines where it is convenient to adopt the wet sump system.

The dry sump system is adopted primarily because of the weight factor involved in carrying the necessary amount of oil for endurance in the crankcase itself, and secondly, because of the necessity for ensuring efficient lubrication under all conditions of flying, *e.g.*, steep climbing and gliding angles, aerobatics, etc.

In the case of the low powered light aeroplane types, the quantities of oil concerned are less and the weight/power ratio is not cut so fine. In addition, in such small machines it is not always feasible to fit in a separate oil tank and connecting pipes. In these cases special baffling arrangements are generally fitted to prevent over oiling.

A dry sump is ensured by embodying separate pressure and scavenge oil pumps, the latter having from 25 to 50 per cent. excess capacity over the former.

A separate oil tank of sufficient capacity is placed as near as possible to the engine consistent with the machine design, and safety from fire on crash and, in addition, arranged as far as possible to get the maximum cooling effect from the slipstream.

This is not always possible and as a consequence in certain classes of machine it is necessary to fit special oil coolers in order to maintain reasonable oil temperatures.

Oil outlet temperatures from the engine of 100°C. are quite frequently experienced; but arrangements are always made by means of coolers to ensure that the return temperature to the engine does not exceed 70°C., otherwise there would be a progressive building up of temperature and consequent deterioration of the lubricant, seeing that the same oil is always in circulation.

The reasons for the high oil temperatures experienced are not far to seek.

It is a fact that in aircraft engines the oil not only has to lubricate bearings and the like, but it also acts as a cooling medium, the extent of which varies with the installation details and the general design of the type.

In order to keep weight/power ratios low, high bearing loadings of the order of 800-1,000 lbs. per square inch are adopted. In addition, piston temperatures are high and although most of this heat is carried away through the rings and skirt, a large amount of cooling is done by oil splash on the underside.

In addition, in some engines, needlessly high rates of circulation of oil are adopted, and this involves picking up a lot of heat from parts which do not require it.

It is significant that rates of oil circulation of from 60 gallons per hour to 400 gallons an hour are employed for engines of approximately the same power.

All these factors tend to overheat the oil and having once done that it is no easy matter to cool it efficiently without excessively large coolers. It is estimated that approximately 2 per cent. of the total fuel energy is dissipated by the oil.

Pressure feed is necessary in order to ensure adequate flow of oil through all the bearings and other parts, and gear-driven pumps are generally adopted for this purpose, chiefly because of their small bulk and weight, simplicity of operation and ease of installation.

They are always fitted with a relief valve loaded to the maximum oil pressure desired in order to obviate bursting of pipes and oil galleries.

The pressures utilised vary a great deal, figures of 40 lb. per sq. in. to 120 lb. per sq. in. being experienced.

There appears to be no special merit in a high oil pressure as such, from the lubrication point of view, as the maintenance of the oil film in any bearing is not dependent upon oil pressure but rather on the viscosity and adhesive character of the oil film combined with what might be termed the Michel effect, due to the rotating shaft and its bearing.

In addition, high oil pressures introduce leakage difficulties and loss of power in pump drives.

The main function of the oil pump is to ensure an adequate flow of oil to all parts under all conditions of temperature and pressure, also to have sufficient margin in capacity to cope with increase of clearances due to wear in the life of the engine. The gear pump does not seem altogether ideal in this respect as its leakage increases rapidly with increase either of temperature or pressure.

It is obvious, of course, that with the fine clearances in bearings and pumps efficient cleaning of the oil is a *sine qua non* and special pressure and scavenge filters are always fitted.

It is difficult, however, to ensure adequate cleaning by these means without having recourse to very fine mesh gauzes and running the risk of choking, in addition to putting a large resistance in the oil circuit.

Many attempts have been made to fit mechanically driven centrifugal cleaners and a large number of Continental engines embody such a feature.

It is obvious that if one can embody in the lubricating oil circuit some means of continuously and effectively cleaning the oil a considerable increase in the life of the bearings between overhauls will thereby result.

A tremendous amount of the wear on bearings is due to the lapping and scoring effect of impurities in the oil.

Some of this is caused on starting up from cold, particularly after an engine has been standing for some time.

The oil film has been squeezed and drained out and metallic contact is involved until such time as the circulating oil reaches the spot. It is during this period that scoring and wear is started.

A recent analysis of sludge content of a centrifugal cleaner disclosed an unduly large percentage of metallic content.

In addition, other impurities, *e.g.*, carbon, sand, etc., are also contributory causes of the trouble, and they can all be dealt with by centrifugal types of cleaner.

Touching on the question of quick circulation of oil from a cold start, this factor involves using an oil which, in addition to having the necessary viscosity at high temperatures, shall also have as low a viscosity at low temperatures as possible in order to cut down to a minimum the warming up period.

This is especially important in fighting machines where the time for take-off is of the utmost importance.

In many cases it is necessary to employ artificial methods for keeping the oil tanks and their contents warm in order to minimise the time for opening up to full throttle.

Another feature which frequently causes trouble is the necessity for adequate and efficient breathing arrangements.

The crankcase volumes are cut to a minimum, the scavenge pump is sucking air part of its time owing to its excess capacity over the pressure pump and we have continual displacement of air and oil mist going on.

This, of course, is one of the contributory causes of the oxidation of the oil which is in process continuously during its passage through the engine.

The breathers should be of adequate capacity and should be so placed in relation to the main volume of the crankcase as to ensure the maximum baffling effect. This is necessary in order that the fluctuations of pressure may be damped out as far as possible before reaching the breather, otherwise considerable loss of oil may take place.

The main factor in controlling the oil consumption of an engine is effective sealing and scraping arrangements on the piston. This generally takes the form of making the bottom ring a special scraper of fairly high pressure—about 14-18 lbs. per sq. in.—and embodying drainage holes through the piston to assist in returning the surplus oil from the cylinder walls to the interior of the crankcase.

The foregoing general remarks cover the bulk of the features common to all types of lubricating systems of modern engines.

The following figures and brief descriptions of typical lubrication systems and their accessories are given:—

Fig. 1.—Bristol "Jupiter" Engines. Lubrication System

Fig. 1 shows a sectional arrangement of the Jupiter VIII. engine and gives us a very good general idea of a modern aircraft engine lubrication system.

This engine is of the well-known 9-cylinder air-cooled static radial type, embodying the Farman bevel reduction gear giving a gear ratio of 2 : 1.

The cylinders are $5\frac{3}{4}$ in. bore by 7.5 in. stroke, and the rating is 440 b.h.p. at an altitude of 4,000 feet and normal speed of 2,000 r.p.m.

The weight of engine complete is 890 lb. and the oil consumption about 16-18 pints per hour. The compression ratio is 5.8 : 1. The normal oil pressure is 60 lbs. per sq. in. and the rate of oil circulation is about 70 to 80 gallons per

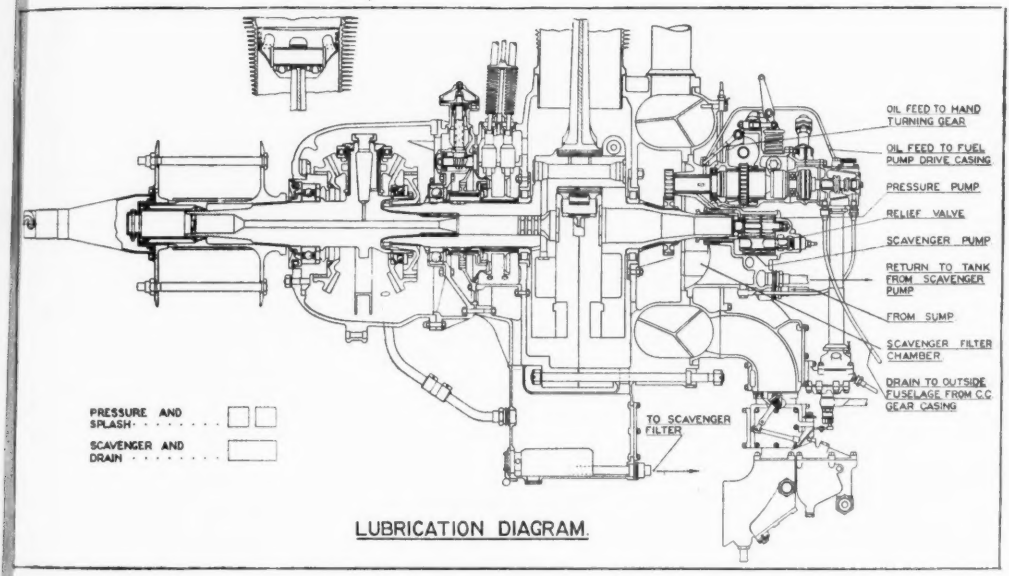


FIG. 1.
Bristol "Jupiter" Engines, Lubrication System.

hour, but capacity of pressure pump is about 200 gallons per hour. The scavenge pump capacity is approximately 25 per cent. greater.

The general layout is broadly on the lines previously described; but there is one feature worthy of special notice and that is the solid big-end construction and split crankshaft which enables a fully floating bush to be utilised. This is a tremendous advantage from the lubrication point of view, it enables a double oil film to be utilised and a correspondingly higher P.V. factor on the big-end.

Fig. 2.—"Jupiter" Oil Pump

This figure gives a very good idea of the detailed construction of the oil pump unit as fitted to "Jupiter" engines.

It will be noted that the pressure and scavenge pumps are of the spur gear type, and that the whole of the unit is simple in design and easy of access and assembly.

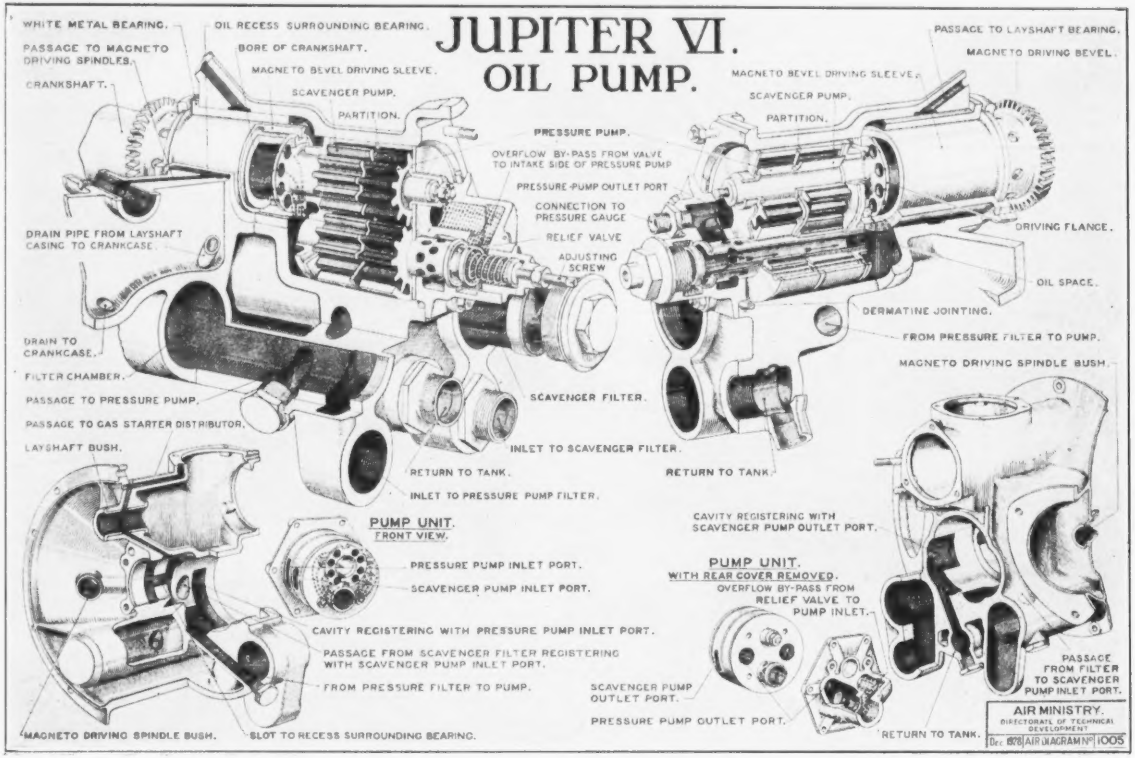


FIG. 2.
"Jupiter" Oil Pump.

FIG. 2.
"Jupiter" Oil Pump.

The pumps, relief valve, pressure and scavenge filters are all embodied in the one unit which is fitted on the back of the engine with a drive for the pumps off the rear end of the crankshaft.

The relief valve by-passes the oil back to the suction side of the pressure pump, and the filters are so housed that they can be readily withdrawn for cleaning purposes, which is necessary after every 10 hours' running.

The pressure pump delivers its oil through the centre of the idler gear spindle to the end of the crankshaft and thence is distributed as per Fig. 1.

This type of construction is typical of most aircraft engine oil pumps, the details of course varying with the engine under consideration.

Fig. 3.—"Jupiter" Oiling System. Installation Diagram

This figure shows a typical oiling installation in the machine.

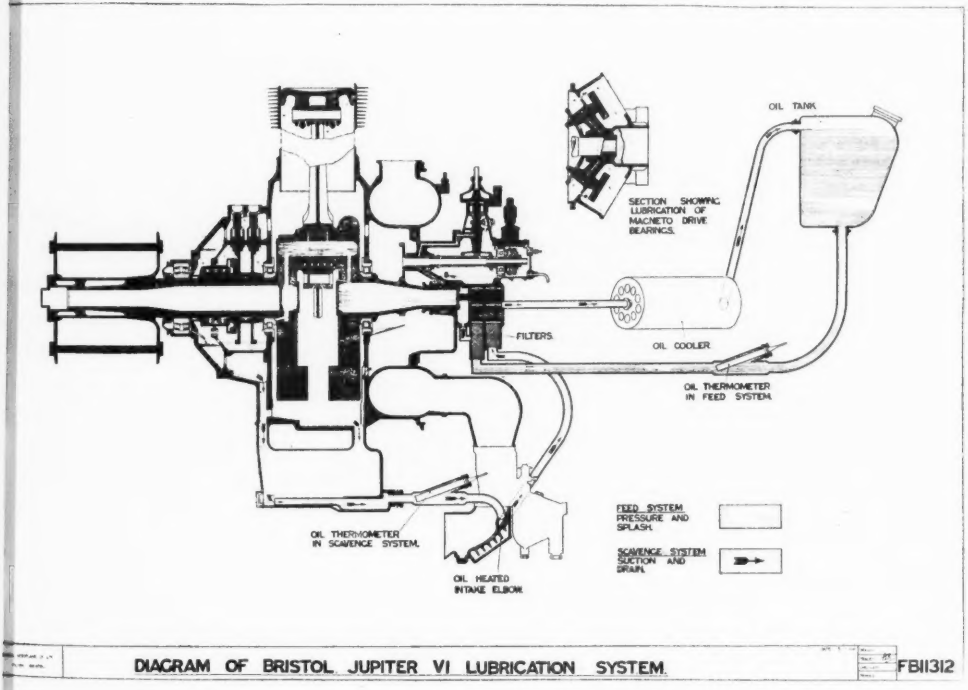

OIL TANK
SECTION SHOWING LUBRICATION OF MAGNETO DRIVE BEARINGS.
FILTERS.
OIL COOLER
OIL THERMOMETER IN FEED SYSTEM.
OIL THERMOMETER IN SCAVENGE SYSTEM.
OIL HEATED INTAKE ELBOW.
FEED SYSTEM PRESSURE AND SPLASH.
SCAVENGE SYSTEM SUCTION AND SPLASH.
DIAGRAM OF BRISTOL JUPITER VI LUBRICATION SYSTEM.
FBII312

FIG. 3.

"Jupiter" Oiling System, Installation Diagram.

The presence of the oil thermometers in the feed and scavenge systems should be noted and also the fitting of the oil cooler in the scavenge pump discharge to the oil tank.

In this particular installation the hot oil on the return from the engine sump was drawn through the air intake elbow with a view to warming the intake air and preventing the freezing up of carburettor diffusers at high altitudes.

Fig. 4.—Armstrong-Siddeley "Jaguar" Engine. Lubrication System

Fig. 4 shows a diagram of the lubrication system of the Jaguar VI. engine.

This engine is of the 14-cylinder double row air-cooled type, embodying a reduction gear of the simple epicyclic type giving a ratio of 0.657 : 1.

The cylinders are 5 in. bore by $5\frac{1}{2}$ in. stroke, and the normal rating of the engine is 460 b.h.p. at a speed of 2,000 r.p.m.

The compression ratio is 5.1 : 1 and the dry weight of the engine about 890 lb.

Relief valve set at 85 lbs. per sq. in. and oil consumption is 14-16 pints per hour.

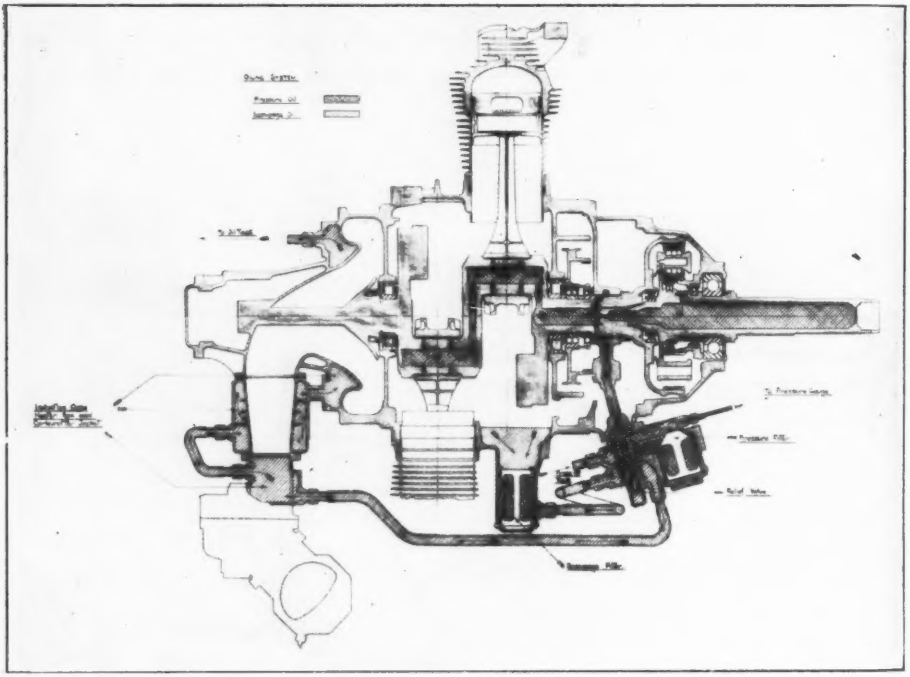


FIG. 4.

Armstrong-Siddeley "Jaguar" Engine, Lubrication System.

Fig. 5.—Rolls Royce "F" Engine. Lubrication System

Fig. 5 shows the general layout of the lubrication system of this engine.

The "F" engine is of the 12-cylinder water-cooled Vee type with a rating of 490 b.h.p. at a normal speed of 2,250 r.p.m.

The cylinders are 5 in. bore by 5.5 in. stroke with a compression ratio of 6 : 1.

The dry weight is 865 lb. The oil consumption is 5 pints per hour, a very low figure for this class of engine.

This engine is of the most modern type, being notable for its low frontal area and weight/power ratio, and also for its good fuel and oil consumption.

Its lubrication system therefore is worthy of more than passing interest.

The dry sump system is adopted, there being two scavenge pumps and one pressure pump.

One scavenge pump draws oil from the forward end of the lower half crankcase through a filter and delivers it to a sump formed at the rear end.

The other scavenge pump draws oil from this sump through another similar filter and delivers it to the service tank.

Both filters are easily detachable downwards for cleaning.

The pressure supply is about 50-60 lbs. per sq. in. and is regulated by a compound relief valve. Delivery is made to each of the main crankshaft bearings

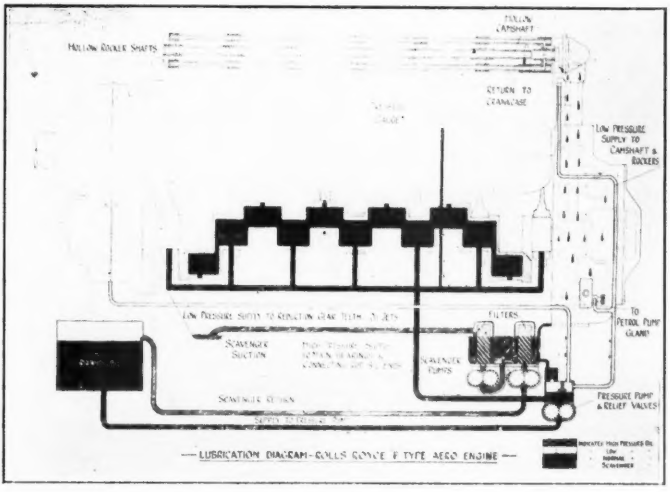


FIG. 5.

Rolls-Royce "F" Engine, Lubrication System.

and thence via oilways in the crankshaft to the connecting rod big-end bearings. Released oil is restrained to a pressure of 2½ to 3 lbs. per sq. in., at which pressure it is delivered to the various auxiliaries, such as the camshaft and rocker mechanism, the reduction gear and petrol pump bearing.

The camshaft drives and timing gears are lubricated by oil which drains back to the crankcase through the camshaft drive housings.

Additional drains are provided by the tubes through which pass the main holding down studs of the cylinder blocks.

The pistons and small-ends of the connecting rods are lubricated by splash, a baffle being provided in the crankcase lower half to prevent an excess of oil being thrown into the cylinders.

Fig. 6.—Napier "Lion" Engine. Lubrication System

Fig. 6 shows a sectional arrangement of the "Lion" engine, together with a diagram of the lubrication system.

The " Lion " engine is noted all the world over and has been associated with probably more records in the air, on the land and sea than any other class of engine.

It is of the 12-cylinder water-cooled broad arrow class, with cylinders of $5\frac{1}{2}$ in. bore by $5\frac{1}{8}$ in. stroke.

The normal b.h.p. is 530 at a speed of 2,350 r.p.m., and the dry weight is 990 lb.

The general arrangement of the lubrication system is typical of this class of engine, but there are one or two features worthy of special notice.

The whole of the inside of the crankshaft is kept under oil pressure, being fed both at the front and rear ends by the pressure pump. In later engines this feed is at the rear only. The oil passes through the crank pins to the connecting

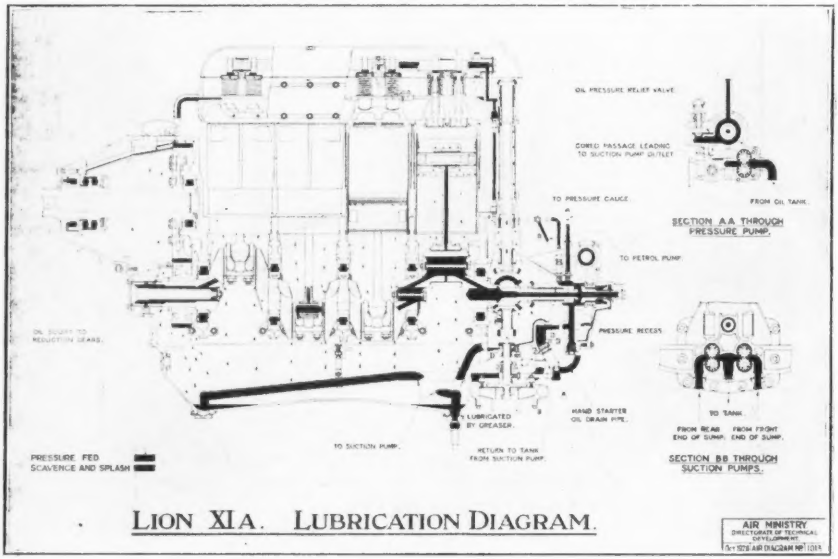

OIL PRESSURE RELIEF VALVE
DRILLED PASSAGE LEADING TO SUCTION PUMP OUTLET
TO PRESSURE GAUGE
FROM OIL TANK
SECTION A.A THROUGH PRESSURE PUMP.
TO PETROL PUMP
PRESSURE RECESS
OIL SQUIRT TO REDUCTION GEARS
HAND STARTER OIL DRAIN PIPE
TO TANK
FROM REAR END OF SUMP.
FROM FRONT END OF SUMP.
TO SUCTION PUMP.
RETURN TO TANK FROM SUCTION PUMP.
PRESSURE FED
SCAVENGE AND SPLASH
SECTION B.B THROUGH SUCTION PUMPS.
LION XI A. LUBRICATION DIAGRAM.
AIR MINISTRY
DIRECTORATE OF TECHNICAL DEVELOPMENT
5-1-1078 AIR DIAGRAM No. 1083

FIG. 6.

Napier " Lion " Engine, Lubrication System.

rod big-ends and to the auxiliary rod wrist pins and up the centre of the connecting rods to the gudgeon pins.

The main journal bearings are of the roller type and are lubricated by splash. A camshaft in each cylinder block is fed under pressure by a connecting pipe from the rear end pressure recess.

The drainage from the camshaft casings is led down the camshaft drive casing at one end and through the reduction gear and thrust bearing casing at the other.

The reduction gears are lubricated by an oil squirt from a passage connected to the front journal bearing which is of the plain type.

The pistons are notable for having two scraper rings.

The normal oil pressure is 55-60 lbs. per sq. in. and the oil consumption from 6 to 12 pints per hour.

Fig. 7.—A.D.C. "Hermes" Engine. Lubrication System

Fig. 7 shows a sectional arrangement of the latest type of "Hermes" light aircraft engine, made by the A.D.C. Aircraft, Ltd., and illustrates very well a typical wet sump system of lubrication.

The lower half of the crankcase, termed the oil sump, contains about 12 pints of oil, which is sufficient for about 4-5 hours' flight.

The oil pump, which is of the gear type, is arranged at the lowest part of the sump so that it is always flooded with oil. The pumping capacity is about 120 gallons per hour.

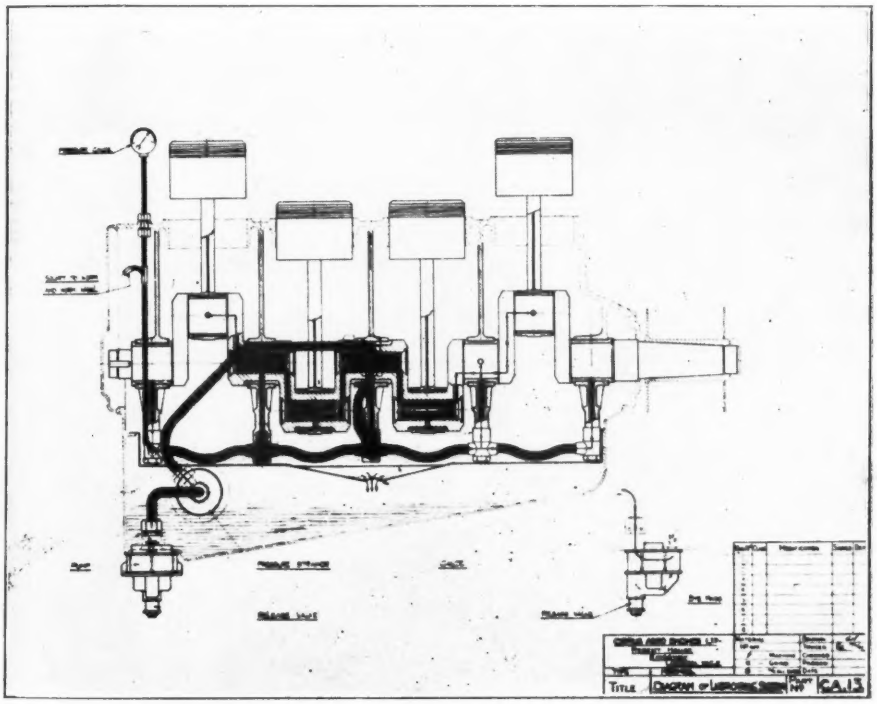


FIG. 7.
A.D.C. "Hermes" Engine, Lubrication System.

It forces the oil through a gauze filter arranged horizontally above the pump, thence through the main delivery pipe to the oil gallery.

Each of the main bearings is connected to the oil gallery by passages so that they receive oil under pressure.

The oil is then conducted through a hole in the crankshaft journal, up the adjacent web to the crankpin, lubricating the big-end bearing and thence by splash to the pistons.

The oil drains back into the sump through a gauze strainer and is used again. A graduated level indicator is provided to ascertain contents of sump.

A relief valve is set to about 30 lbs. per sq. inch.

External parts, such as rocker and valve gear, are lubricated by a grease gun system.

This engine is of the four-cylinder in-line air-cooled type, rated at 105 b.h.p., normal speed 1,900 r.p.m., weight 300 lbs., 114 mm. bore, 140 mm. stroke, compression ratio 5 : 1.

Fig. 8.—Combined Oil Cooler and Cleaner

Fig. 8 shows a novel form of combined centrifugal oil cleaner and cooler. This instrument is the invention of Major Carter, of the R.A.E., Farnborough, and is being put into production by Messrs. S. Smith and Sons.

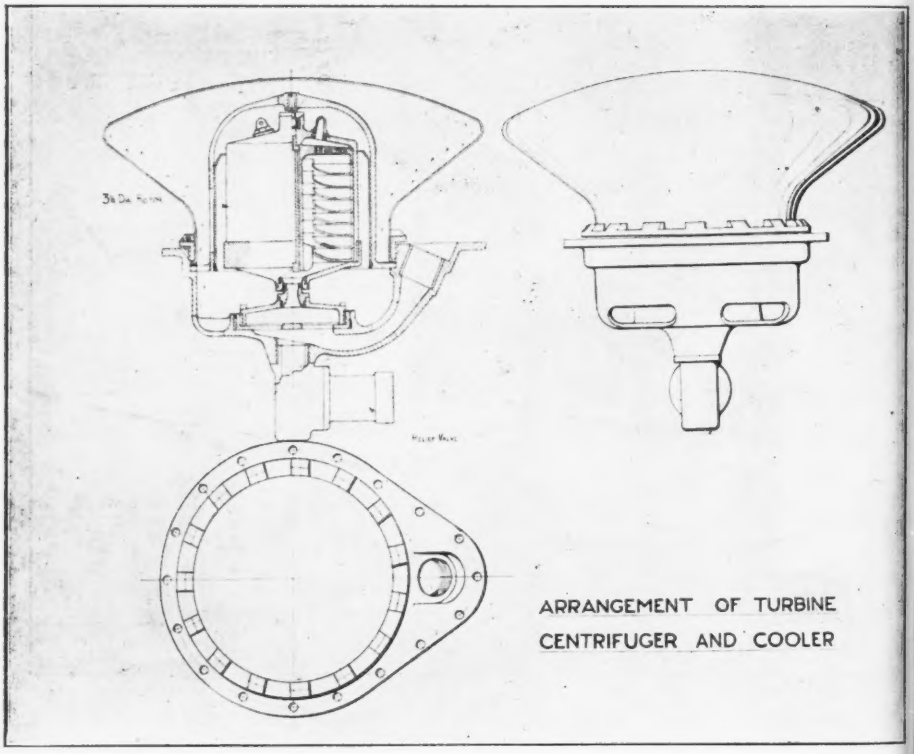
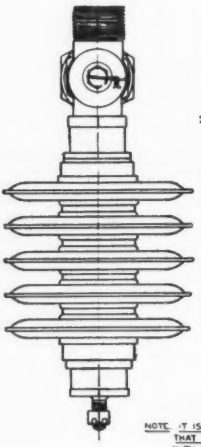


FIG. 8.
Combined Oil Cooler and Cleaner.

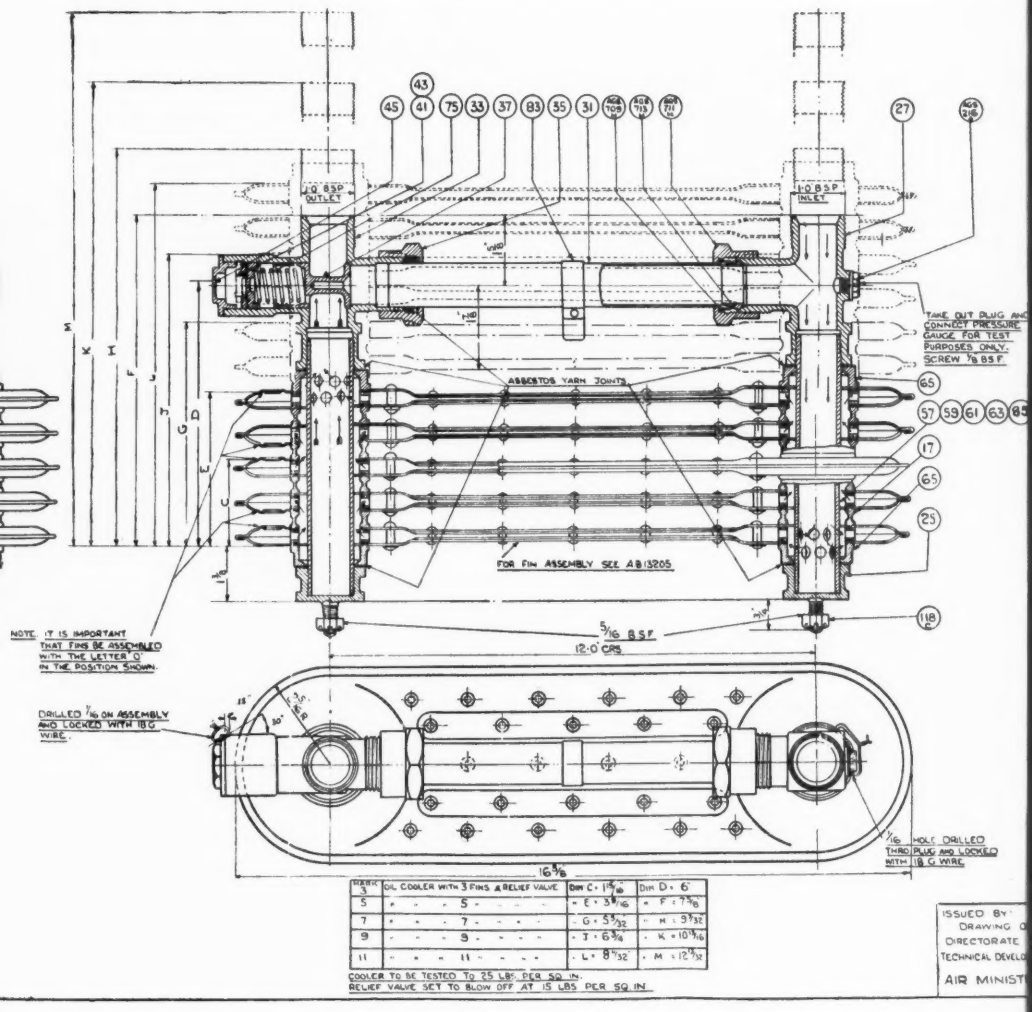
It consists primarily of a rotor through which the oil passes under pressure, and which is caused to turn at high speed by the reaction of the issuing oil and air from jets situated at the top of the rotor.

The air passes into a central tube and thence makes its exit through air reaction jets. The working pressure is set by adopting an oil jet size appropriate to the engine. A relief valve is provided to limit the maximum pressure when the oil is cold.



NOTE. IT IS IMPORT
THAT FINS BE
WITH THE LE
IN THE POSIT

DRILLED 1/16
AND LOCKED
WIRE

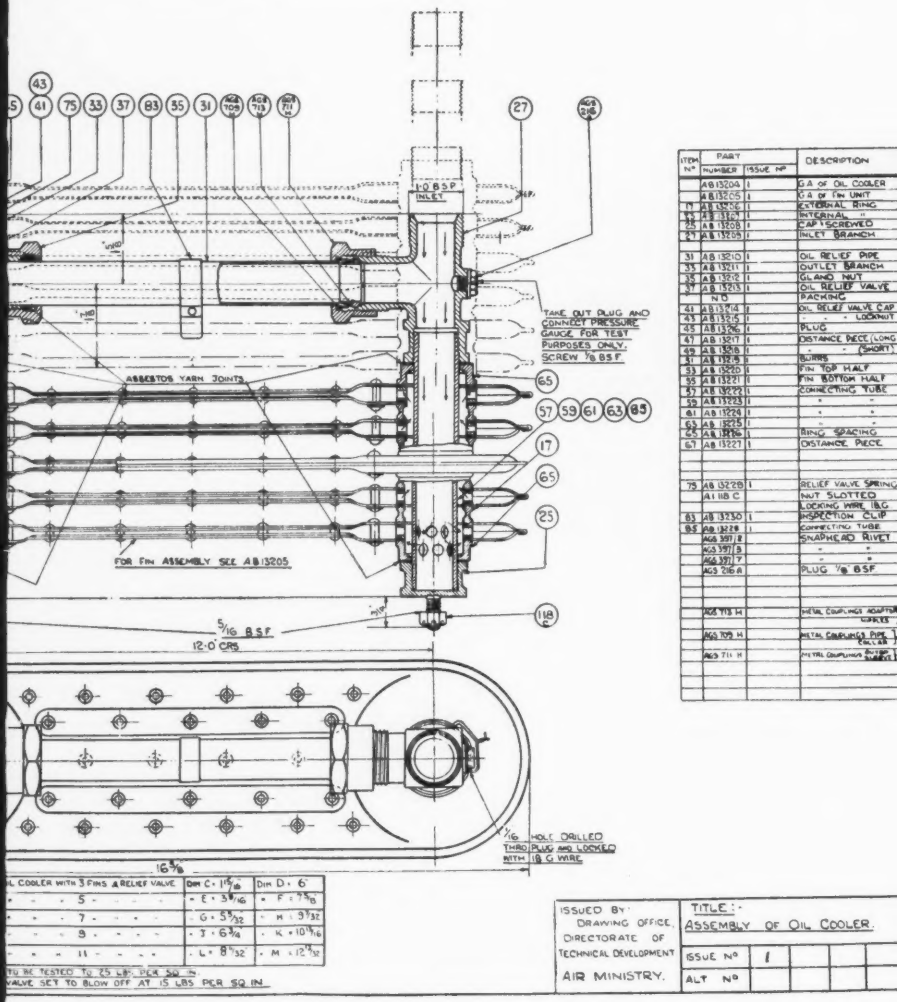

1.0 BSP OUTLET
1.0 BSP INLET
ASBESTOS YARN JOINTS
FOR FIN ASSEMBLY SEE AB13205
TAKE OUT PLUG AND CONNECT PRESSURE GAUGE FOR TEST PURPOSES ONLY. SCREW 1/8 BSF
NOTE. IT IS IMPORTANT THAT FINS BE ASSEMBLED WITH THE LETTER 'O' IN THE POSITION SHOWN.
DRILLED 1/16 ON ASSEMBLY AND LOCKED WITH 18 G WIRE.
5/16 BSF
12.0 CRS
1/16 HOLE DRILLED THRO PLUG AND LOCKED WITH 18 G WIRE
16 5/8
ISSUED BY
DRAWING O
DIRECTORATE
TECHNICAL DEVELO
AIR MINIST

DASH NO.	OIL COOLER WITH 3 FINS & RELIEF VALVE	DIM C	DIM D
5	" " " 5 " " " "	" E = 3 1/16	" F = 7 3/16
7	" " " 7 " " " "	" G = 5 3/32	" H = 9 3/32
9	" " " 9 " " " "	" J = 6 3/4	" K = 10 1/16
11	" " " 11 " " " "	" L = 8 3/32	" M = 12 1/32

COOLER TO BE TESTED TO 25 LBS. PER SQ. IN.
RELIEF VALVE SET TO BLOW OFF AT 15 LBS PER SQ. IN.

FIG. 9.

Vickers-Potts Oil Cooler.


1·0 B.S.P. INLET
TAKE OUT PLUG AND CONNECT PRESSURE GAUGE FOR TEST PURPOSES ONLY. SCREW 1/8 B.S.F.
ASBESTOS YARN JOINTS
FOR FIN ASSEMBLY SEE A.B.13205
5/16 B.S.F.
12·0 CRS
1/16 HOLE DRILLED THRO PLUG AND LOCKED WITH 18 G WIRE
16 5/8
OIL COOLER WITH 3 FINS & RELIEF VALVE
DIM C · 1 15/16
DIM D · 6"
· · 5 · · ·
· E · 3 9/16
· F · 7 5/8
· · 7 · · ·
· G · 5 5/32
· H · 9 1/32
· · 9 · · ·
· J · 6 3/4
· K · 10 7/16
· · 11 · · ·
· L · 8 5/32
· M · 12 7/32
TO BE TESTED TO 25 LBS. PER SQ. IN.
VALVE SET TO BLOW OFF AT 15 LBS PER SQ IN

ITEM No	PART NUMBER	ISSUE No	DESCRIPTION
	AB 13204	1	G.A. of OIL COOLER
	AB 13205	1	G.A. of FIN UNIT
19	AB 13206	1	EXTERNAL RING
23	AB 13207	1	INTERNAL "
25	AB 13208	1	CAP SCREWED
27	AB 13209	1	INLET BRANCH
31	AB 13210	1	OIL RELIEF PIPE
35	AB 13211	1	OUTLET BRANCH
35	AB 13212	1	GLAND NUT
37	AB 13213	1	OIL RELIEF VALVE
	N.D.		PACKING
41	AB 13214	1	OIL RELIEF VALVE CAP
43	AB 13215	1	" " " LOCKNUT
45	AB 13216	1	PLUG
47	AB 13217	1	DISTANCE PIECE (LONG)
49	AB 13218	1	" (SHORT)
51	AB 13219	2	BURRS
53	AB 13220	1	FIN TOP HALF
55	AB 13221	1	FIN BOTTOM HALF
57	AB 13222	1	CONNECTING TUBE
59	AB 13223	1	" "
61	AB 13224	1	" "
63	AB 13225	1	" "
65	AB 13226	1	RING SPACING
67	AB 13227	1	DISTANCE PIECE
75	AB 13228	1	RELIEF VALVE SPRING
	A1 118 C		NUT SLOTTED
			LOCKING WIRE 18 G
83	AB 13230	1	INSPECTION CLIP
85	AB 13231	1	CONNECTING TUBE
	AGS 397/2		SNAPHEAD RIVET
	AGS 397/3		" "
	AGS 397/7		" "
	AGS 216 A		PLUG 1/8 B.S.F.
	AGS 713 H		METAL COUPLINGS ADAPTER WORKS
	AGS 709 H		METAL COUPLINGS PIPE COLLAR
	AGS 711 H		METAL COUPLINGS NUT WORKS

ISSUED BY DRAWING OFFICE, DIRECTORATE OF TECHNICAL DEVELOPMENT AIR MINISTRY.	TITLE:- ASSEMBLY OF OIL COOLER.
	ISSUE No 1
	ALT No

FIG. 9.

Vickers-Potts Oil Cooler.

DESCRIPTION	No. 3 INT OUT	No. 5 INT OUT	No. 7 INT OUT	No. 9 INT OUT	No. 11 INT OUT		MATL	SPEC	REMARKS
GA of OIL COOLER									
GA of FIN UNIT									
EXTERNAL RING	4	8	12	16	20		DURAL	L1	- AB 13204
INTERNAL "	6	10	14	18	22		"	"	- AB 13203
CAP SCREWED	2	2	2	2	2		MSS	S1	- AB 13204
INLET BRANCH	1	1	1	1	1		MALLEABLE IRON	CI	"
OIL RELIEF PIPE	1	1	1	1	1		DURAL	T4	"
OUTLET BRANCH	1	1	1	1	1		MALLEABLE IRON	STD 184	"
GLAND NUT	1	1	1	1	1		BRASS	B6	"
OIL RELIEF VALVE	1	1	1	1	1		"	"	"
PACKING	1	1	1	1	1		COMPO		"
OIL RELIEF VALVE CAP	1	1	1	1	1		MSS	S1	"
" " LOCKNUT	1	1	1	1	1		"	"	"
PLUG	1	1	1	1	1		BRASS	B6	"
DISTANCE PIECE (LONG	6	10	14	18	22		BRASS	B6	- AB 13205
" (SHORT)	30	50	70	90	110		"	"	"
BURRS	84	168	252	336	504		"	B12	"
FIN TOP HALF	5	5	7	9	11		"	"	"
FIN BOTTOM HALF	5	5	7	9	11		"	"	"
CONNECTING TUBE	-	2	-	-	-		MSS	T1	- AB 13204
" "	-	-	2	-	-		"	"	"
" "	-	-	-	2	-		"	"	"
" "	-	-	-	-	2		"	"	"
RING SPACING	4	6	4	4	4		DURAL	L1	"
DISTANCE PIECE	48	80	112	144	176		BRASS	B6	- AB 13205
RELIEF VALVE SPRING	1	1	1	1	1		SPG ST	-	- AB 13206
NUT SLOTTED	2	2	2	2	2		BRASS	B6	"
LOCKING WIRE 18G	-						BRASS	B6	"
INSPECTION CLIP	1	1	1	1	1		DURAL	L3	"
CONNECTING TUBE	2	-	-	-	-		MSST	T1	"
SNAPHEAD RIVET	30	50	70	90	110		COPPER		- AB 13205
" "	48	80	112	144	176		"		"
" "	6	10	14	18	22		"		"
PLUG ⅛ BSF	1	1	1	1	1		BRASS	B6	AB 13206
									"
									"
METAL COUPLINGS ADAPTOR SLEEVE	1	1	1	1	1		BRASS	B6	"
METAL COUPLINGS PIPE COLLAR	1	1	1	1	1		BRASS	B.6	"
METAL COUPLINGS NUT	1	1	1	1	1		BRASS	B.6	"

OIL COOLER	DRAWN	TRACED	SKETCH No
	R A E	C A A	
	CHECKED	APPROVED	AB 12871
	8/10 20/12/39		

During its passage through the rotor the impurities in the oil are separated out by centrifugal action and collected in a series of annular trays within the rotor.

An extracting device is incorporated to enable the trays to be removed with ease for cleaning when fouled with sludge, metallic particles and grit.

A strainer is incorporated in the extracting device to arrest large particles, the holes in this strainer being smaller than the jet sizes and thus choking of the jets is obviated.

This unit is normally fitted on top of the oil tank and is coupled to the return oil pipe from the scavenge pump of the engine.

Aerated oil under a pressure of approximately 40 lbs. per sq. inch passes through the rotor and issues in jets which spray upon the inner surface of a large domed cooling element, the outer surface of which is exposed to the slip-stream of the machine. The cooled oil drains down into the tank through the air space above the oil in the tank.

Tests have shown that the cooling is very efficient, this is undoubtedly contributed to by the scrubbing action of the jets impinging upon the cooling element, combined with the good distribution of the oil over the surface effected by the spinning of the rotor.

The model shown is capable of dealing with about 100 gallons per hour, weighs about 5 lb. and the rotor has a speed of approximately 7,000-8,000 r.p.m.

It should be cleaned about every ten hours' flying.

Fig. 9.—Vickers Potts Oil Cooler

Fig. 9 shows a form of oil cooler which is used largely in the Royal Air Force. Its chief characteristic is its low aerodynamic resistance, and the fact that it can be placed in any convenient position near the engine and arranged so that the air flow is along either the major or minor axis of the fins.

It consists of a series of hollow fins threaded on two tubes and arranged for series flow, *i.e.*, through each fin or element in turn.

A by-pass valve is inserted between the inlet and outlet pipes to provide an alternative path for the oil when starting from cold and to prevent excessive pressures on the fins.

The internal construction of the cooling element is such that the oil is exposed in thin layers to the cold surface of the fins; also the spacers between the fins break up the flow of the oil by eddying and thus cause rapid transfer of heat.

The external space between the fins, which space is increased by the local flattening of the latter, enables the air to pass freely between them without causing undue drag or air resistance.

The cooling surface per fin is about 145 sq. ins. and the reduction of temperature per fin varies from 1° to 6°C., according to the rate of flow and temperature of the air.

Normally a five-fin cooler is suitable for an engine of about 450 b.h.p., but the number of fins is of course largely dependent upon the general installation conditions of the engine.

The weight of such a cooler is about 10 lb. and its equivalent drag in h.p. just over 1 h.p. It is supplied in 5, 7, 9 and 11 elements.

Figs. 10 and 11.—"Bristol" Oil Cooler

These figures show a sectional drawing and a photograph of the Bristol type oil cooler.

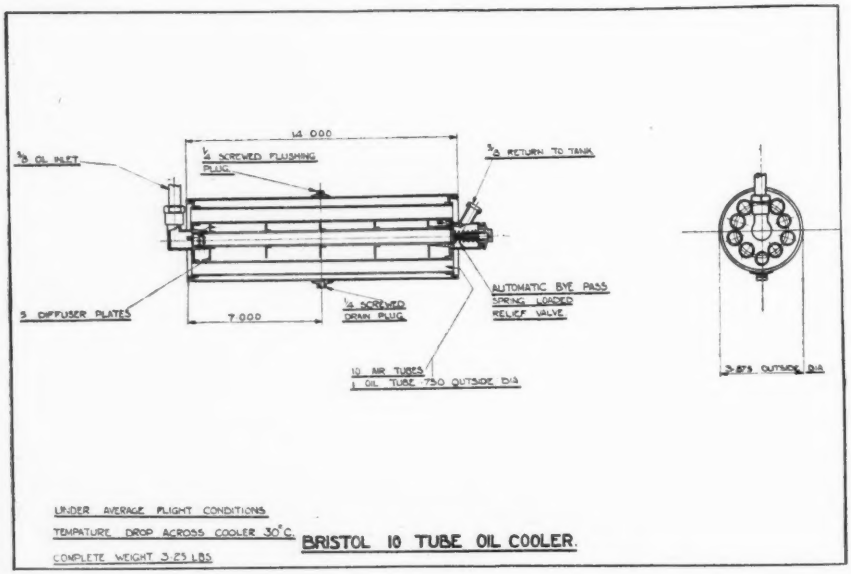
This cooler is of the tubular type, the number and size of tubes varying with the capacity and size of cooler and the type of machines for which it is intended.

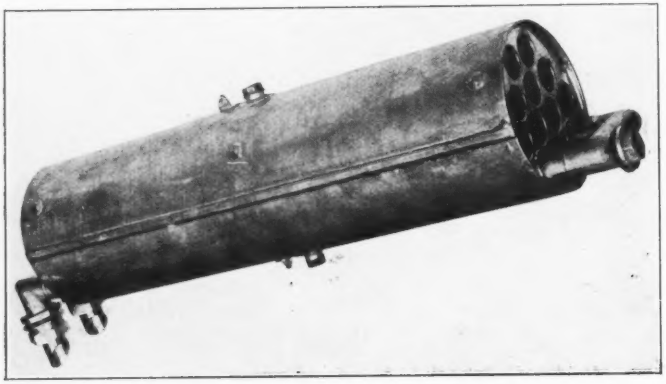
The particular one illustrated is a 10-tube cooler suitable for fast machines.

Its weight is about $3\frac{1}{4}$ lbs. and designed temperature drop across cooler about 30°C.

The cooler is self-regulating by means of a by-pass valve which also acts as a safety valve.

The cooler is constructed from copper tube 28 gauge.



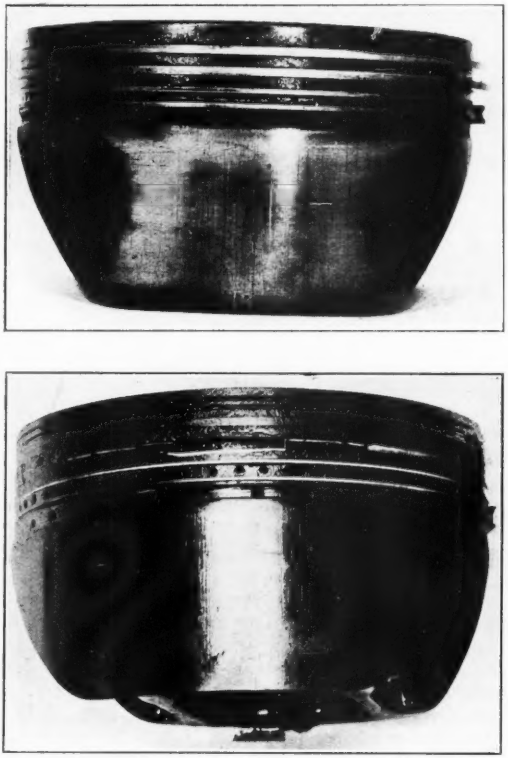


FIGS. 10 AND 11.

"Bristol" Oil Cooler.

Figs. 12 and 13.—Pistons after Test on Mineral and Castor Oil

These two photographs give a very striking comparison of a piston after a successful type test of 100 hours on mineral oil and a similar design of piston in the identical engine after failure to pass this type test, owing to gumming of the piston rings through using a castor base oil. It will be noted that in the latter case, the top rings are completely gummed up, the second ring being broken into a number of fragments, consequent on progressive local nipping and bending.



FIGS. 12 AND 13.
Pistons after Test on Mineral and Castor Oil.

FURTHER DEVELOPMENT WORK

In view of the steady increase in use of aircraft for all purposes and the demand for increased efficiency and reliability from the aircraft engine as a consequence, it becomes of paramount importance to improve the lubrication systems and the lubricants utilised.

The gumming of the piston rings has been referred to and this is a real bottle-neck which requires further development work.

The use of ball and roller bearings wherever possible, the substitution of plain bearings where used by the floating bush type, and the extension of pressure feed to all the more heavily loaded parts will assist in this direction.

In furtherance of the policy of using mineral oils, the system of oilways requires careful design to prevent pockets of sludge forming.

The extension of evaporative cooling to aircraft engines will further complicate the question of prevention of gumming of pistons, and will require investigation. Here again we have definite evidence that mineral oils are desirable.

As regards the lubricants, we must look to the oil technologists to provide us with oils which are more stable and do not oxidise so readily, and in this connection it is interesting to observe that Callendar, King and Mardles have taken out a patent on the application of a dope to lubricating oils with this particular object in view.

We have heard a lot about dopes for fuels, but dopes for oils opens up an interesting field of thought.

It is early days to say whether this idea will eventually prove of utility and only experience will show.

There is another school of thought which believes in the graphiting of oils for lubrication, and although certain benefits as regards bearing life may be expected from this, the bugbear of carbon deposit and sludge is all against such a practice.

Conclusion

It will be noted that the Service side of this question has been stressed rather, the reason for this is the fact that in this country, up to the present time, aircraft engines have been designed and developed primarily for the Royal Air Force.

Consequently the conditions of such development react to a large degree on the use of these engines for civil purposes.

As civil aviation increases there will be a demand for engines which satisfy its own particular set of conditions and it will then be the duty of the aircraft engine designer to satisfy such a demand.

The two branches, of course, have a tremendous amount in common, but there are points of divergence.

I cannot conclude this paper without expressing my best thanks to the Air Ministry and my colleagues there for permission to publish and for help in the preparation of same.

In addition, I desire to express my thanks to the many firms who so kindly assisted with preparation of the drawings, notably Messrs. Bristol Aeroplane Co., Armstrong-Siddeley Motors, Ltd., Rolls-Royce, Ltd., A.D.C. Aircraft, Ltd., S. Smith and Sons, and Vickers, Ltd.

Last, but not least, I should like to pay a tribute to the oil firms themselves, who have been doing yeoman service for a number of years in developing high grade lubricating oils for aircraft engines. In this connection particular mention should be made of Messrs. Silvertown Lubricants, Ltd., Shell Mex, Ltd., and C. C. Wakefield and Co., who have all carried out a tremendous amount of laboratory and testing work in the effort to raise the standard of oils.

Discussion

The President: The problem of lubrication was very important indeed, a complex problem too on which a great many ill-informed statements had been made. This meeting would serve to straighten out the situation to a great extent, because there were present not only the principal users of aircraft engines, but also those engaged in research on lubricants and the production thereof.

The paper served to indicate clearly the necessity for arriving at a standard method of analysis, so that lubricating oils could be compared on a concrete basis; it seemed that the time had arrived when a discussion might be initiated by some authority such as Major Bulman, who was responsible for aero engine design at the Ministry, with a view to arriving at a standard of comparison. The last two illustrations shown by Mr. Foord, dealing with the comparison of a pharmaceutical castor oil and a mineral oil, were very interesting. The recent tests at Bristol, wherein an old Jupiter engine which had been in use for three or four years was tested when using a mineral oil and also a pharmaceutical base oil, showed that the advantages were with the pharmaceutical base oil, in that troubles in regard to the oiling up of the plugs and so forth were not nearly so marked as when the mineral oil was used. With regard to the accumulation of sludge in the oil ducts, crank pins, and the like, the tests referred to by Mr. Foord had extended over a period of about 100 hours, but it would probably be necessary for him to carry out tests extending over more than double that period before he could be sure that the mineral oil was really so satisfactory as had been hoped from the point of view of the absence of sludge. The problems of cooling and cleaning were of extreme importance. At present the prime mover as used in aircraft suffered tremendous disabilities, and it was remarkable that it functioned so efficiently and with such little wear as it did under present circumstances. Mr. Foord had referred to only one type of cleaner, namely, that developed by Major Carter, of the R.A.E. It would be interesting to know, however, whether he had carried out tests with a cleaner of the streamline flow type, as developed by Dr. Hele-Shaw, and what was his opinion of that type of cleaner. With regard to the addition of graphite to lubricants, he asked whether Mr. Foord's remarks related to the addition of graphite in the colloidal form. The graphite produced by Acheson, in the States, was not of a truly colloidal character; if truly colloidal graphite were mixed with oil, what would be the result? There seemed to be possibilities. In any event, to-day there was no more suitable lubricant for the valve guides, etc., of air-cooled engines than Acheson graphite. It had the merit besides being an admirable lubricant of being unaffected by the temperature met with in normal working.

Dr. A. E. Dunstan (President, Institution of Petroleum Technologists, and Chief Chemist to the Anglo-Persian Oil Co., Ltd.): He was particularly impressed with Mr. Foord's remarks with regard to the need for close collaboration of the oil technologist and the engine designer. It was impossible to imagine anything more necessary than that, not only in regard to aircraft engine but also motor car engine design. The engineer was too apt to state certain conditions and then, in blind and trusting faith, to expect the chemist to live up to these conditions. When studying the paper, and when considering the problem of lubrication generally, one was inclined to think that the bigger developments made were those of the mathematician, the physicist and the engineer, and that the chemist had taken rather a back seat in regard to recent developments. The chemist, however, was up against extraordinary difficulties in trying to understand the mechanism of lubrication. He was handling a mixture which was extraordinarily complicated and, with all the technique at his disposal, he had practically no means of elucidating the nature—the physical and chemical properties—of the components of this mixture.

He joined issue with Mr. Foord on the question of oiliness. It was all very well to say that one did not place very much faith in this somewhat mysterious property, but one had never defined that property, and they were all more or less in the dark and were using the word "oiliness" to hide a large amount of ignorance. At the same time, he did feel that this phenomenon had a real significance, ill-defined though it be. Anyone who had carried out experiments with the Stanton petroleum, for example, and had learned by practical experience

the remarkable effects of adding traces of fatty acids—a line of practice which was introduced by Southcombe several years ago—would realise that there was something in the term "oiliness." When one followed Sir William Hardy's work on the static coefficient of friction, and realised the remarkable way in which the coefficient varied in the homologous series with increase of molecular weight, one was again led to believe that this phenomenon was one which would in the future throw considerable light on the whole theory of lubrication. In quite recent years work had been carried out in his laboratory in regard to the heat of wetting of the bearing surface with various lubricating oils, and in this connection he emphasised that we were not concerned so much with a lubricating oil as with a lubricating system, *i.e.*, the bearing metal played its part equally with the oil. One point which had been established definitely was that unless there were in the oil certain polar components, by virtue of which there was some physical and chemical attachment and combination between the elements of the system—the bearing metal on the one hand and the oil on the other—we did not get lubrication as we know it. That point was worthy of very serious attention.

With regard to the so-called oxidation tests, he was inclined to think that the Air Ministry test represented an extraordinarily great advance in the direction of finding out how the tests of a given oil altered after oxidation finished. In this connection he drew attention to a statement in last year's report of the American Society for Testing Materials. The committee responsible for producing standard tests in the States, in a reference to oxidation tests, had stated:—

> "With regard to the various methods put forward, none of these methods, whether good or poor from the point of view of laboratory technique, has been correlated with service behaviour to such a degree as to make possible any agreement as to which tests should be standardised for universal use."

Also, in discussing the significance which could be placed upon the so-called coke test, the report stated:—

> "It is frequently claimed that the quantity of carbon deposited in cylinders and on pistons is proportional to the carbon residue of the oil. Under ideal conditions this is possibly true, but with average operative conditions other factors as, for example, the viscosity of the oil, the mechanical condition of the engine, and the conditions of carburation of the fuel, may predominate in controlling carbon deposition."

Of all the tests put forward to control the quality of a lubricant, he asked, how many had any actual value?

Mr. Pye (Deputy Director of Scientific Research at the Air Ministry): The subject of lubrication of aircraft engines was an extraordinarily suitable subject for discussion by a Society such as this. In reference to the difficulty of arriving at specifications, and as bearing on the remarks of Dr. Dunstan with regard to the coke test, before and after oxidation, and its relation to sludge formation in the engine, he would like to mention some tests which had come to his notice not long ago, but which were not connected with the Air Ministry. There were two oils tested, one of which gave an increase in coke number, after oxidation, of 2.37, whereas in the case of the other oil the increase was only 0.81. The first one, which was infinitely the worse, according to the coke numbers, deposited *less than half* the amount of sludge in the centrifuge than did the other after a 50 hours test in the engine, and only *one-sixth* the amount of carbon on the piston. He mentioned that experience in order to illustrate the point that oils were devilish tricky things, and one must be extraordinarily wary in trying to decide from laboratory tests what an oil would do in an engine in service.

During the reading of the paper he had found himself wishing constantly that he could turn to books of reference on chemistry and physics in order to refresh his memory, because the problem of lubrication seemed to lead us at once, as did the problem of combustion, to a study of some of the most difficult problems in the world of molecular physics and chemistry. Sir William Hardy had emphasised the supreme importance of surface films; indeed, he had gone so far as to say that a surface film was equivalent to a fourth state of matter, because the physical constants for this state were all different from those in the other three states, the solid, the liquid and the gaseous. He had demonstrated the importance of surface films by an extremely pretty experiment with a teacup. A dry, clean teacup would slither about in the saucer, and that was due entirely, as Sir William Hardy had shown, to a surface film. The spilling of a little tea into the saucer would stop it, because the tea reduced the effectiveness of the surface film. Again, if the surface film were removed from the clean teacup and saucer without wetting, they would no longer slide, but that was an extremely difficult thing to do. This problem of surface condition was of supreme importance. Although he agreed with Mr. Foord that the problem of oiliness and of surface conditions was rather masked in the practical problem by questions of sludge formation, etc., yet we knew so little about the molecular conditions under which lubrication occurred that it was likely that at any moment these abstruse scientific considerations might flare up and become really important. In a 500 h.p. engine something like 50 h.p. was dissipated in friction losses, and by means of further researches, such as those of Sir William Hardy, a considerable reduction of those losses seemed not at all outside the realms of possibility.

Referring to the very important practical point of the dependence of viscosity upon temperature, he asked how necessary was it that the viscosity of the lubricant should vary so much with the temperature? Was it not conceivable that in the future we might no longer have to endeavour to obtain a flat viscosity curve by accepting what nature gave us in the way of crudes and blending them, but that we might be able to produce artificially, so to speak, an oil of which the viscosity variation with temperature was far less?

By way of illustrating the importance of surface conditions and our ignorance of them, he asked if anyone present could say why glycerine was not a lubricant? Its viscosity varied with temperature very much as did that of lubricating oils, and yet no one would seriously consider its use as a lubricant. Presumably the surface condition was all wrong, and it had not ' oiliness."

Reference had been made by Mr. Foord to the bulk of the oils being oxidised by heat in the presence of air, and he had also said that the process of oxidation proceeded while the oil was circulating through the engine. Unquestionably oxidation occurred, but of what proportion of the oil? Castor oil and mineral oil, of course, must be treated entirely separately in this connection. Castor oil was more or less a homogeneous substance, chemically known as an ester—which was a first cousin of an alcohol—and the first product of oxidation was a very weak acid, known as ricinoleic acid. It was important to know what constituents of an oil were subject to oxidation, and whether or not the process of oxidation was confined to a small proportion of the oil. In this connection some interesting experiments had been carried out by Sir William Hardy, using boundary lubrication subject to a gradually rising temperature, in order to test the conditions in which seizure occurred. He had carried out the experiment in an atmosphere of oxygen and an atmosphere of nitrogen, and had found that oils gave a more or less steady coefficient of friction until a certain temperature was reached; then there was a sudden increase of friction, and the equivalent of seizure occurred. With ordinary lubricating oils the lubricated condition was maintained at a much higher temperature in an atmosphere of nitrogen than in an atmosphere of oxygen. The interesting point was, however, that when he

had tried medicinal paraffin oil—which was produced by some process, as the result of which, it was suggested, it contained none of the unsaturated hydrocarbons—it was found that it behaved exactly similarly whether in an atmosphere of oxygen or nitrogen, and had the full characteristics shown by an ordinary lubricating oil in an atmosphere of nitrogen. That opened up great possibilities, because the suggestion was that the constituents which were subject to oxidation, and which controlled the temperature at which incipient seizure occurred, were constituents which were present in ordinary lubricating oil and absent from the medicinal paraffin. Thus there was opened up the possibility of far higher temperatures being sustained without oxidation and without incipient seizure. Mr. Foord's paper and the discussion upon it would be extremely valuable, because he foresaw that at any moment some of these apparently recondite researches might result in discoveries of prime importance, enabling us to utilise much power which up to the present was dissipated in friction.

Mr. KEWLEY (Chief Chemist to the Shell Group): This problem of producing an ideal combination of engine and lubricating oil could be approached from two directions—either from the point of view of the oil or from the point of view of the engine. The task set before the chemist, to produce an oil possessing all the ideal characteristics laid down by Mr. Foord, was a very great and very difficult one. It was very much more difficult than that of producing a motor spirit, for example, because the higher the boiling points of the petroleum products with which we had to deal, the more complicated their molecular structure became, and we were incapable, so far as he knew at present, at any rate, of changing hydrocarbons, of high molecular weight, of one type into another, or at least, of changing them in any direction in which we should like. Consequently, we were faced with the problem of restricting the supplies of lubricating oils eventually to the particular types of hydrocarbons which were available. Unfortunately, the classes of hydrocarbons which satisfied certain of the ideals laid down by Mr. Foord did not constitute by any means the bulk of the world's crude petroleum. They were derived from the geologically older rocks, whereas most of the oil produced from more recently discovered oilfields came from rocks of younger geological age, and were hydrocarbons of a different type; they were of the type having a relatively steep viscosity curve. Therefore, he believed that eventually the engine designer would endeavour to modify his engine to suit the types of hydrocarbons available, rather than expect the chemist to produce an oil to satisfy the stringent conditions demanded at present by certain engines.

Discussing the problem of oiliness, he expressed the view that a great deal too much stress was laid upon it, and that it was not of very great importance in the practical conditions under which an engine was lubricated. It was quite true that the effect of two oils, one possessing polar bodies and the other without them, or one possessing oiliness and the other without it, might be different under limiting conditions, but he had always felt that no one would dare to run an engine under the conditions under which the oiliness of the oil would really play an effective part. In other words, engines should run under conditions of flooded lubrication. If the conditions under which an engine were running were such that at some time part of its lubrication system had to work under limiting conditions where the oiliness factor had some effect, then the eventual seizure would probably be delayed by only a few minutes. No one would intentionally incur the risk of running under such conditions.

Mr. HALL (Chief Engineer, Imperial Airways): He had learned two notable things at that meeting. One was that Mr. Foord inclined to the use of mineral lubricants in substitution for those having a castor base. The second was that the oil technologists appeared to have concluded that their tests, intended to identify those components which went to make a good oil, were not much good.

He had suspected it for a long time, but had not expected confirmation from the horses' mouths, so to speak. He believed, however, that the oil technologists under-rated themselves, and he knew of at least one good oil which had been evolved as the result of study and hard work by those gentlemen. Speaking as one who had been responsible for many thousands of hours of aircraft engine running, he thought those present might be interested to learn how he became a strong advocate of mineral oil. Some four years ago he and his colleagues had been cursed—there was no other word for it—with the continual gumming up of piston rings in a water-cooled aircraft engine. It was not of modern type, but it was a very good engine, and time after time he had had such engines taken out of aircraft after short periods of service and had stripped the cylinders off and found the pistons and rings veritable masses of coke. These engines had hitherto been lubricated with castor oil and it was decided to try mineral oil and also to increase the side clearance of the piston rings. Investigation on the test bed showed a four per cent. increase in power and many thousands of hours of flight had failed to produce a single gummed ring or appreciable loss of power between overhauls. Doubtless the increased clearances had contributed to this improvement, but in his opinion it was only to a minor extent, and it was his view that the adoption of mineral oil in substitution for the castor oil previously used, had resulted in the number of hours running of the engine between overhauls being increased from anything up to one hundred and fifty hours to three hundred hours, and he asserted with confidence that these engines could now easily be made to run 600 hours between overhauls. He had watched for any tendency to deposit sludge and had found that the deposit in that type of engine, when using mineral oil, was negligible. After 600 hours running it was found that about one-third of the volume of the crank pin bores was occupied by a black slimy mass which was probably fluid at working temperature.

The introduction of modern air-cooled aircraft engines to the heavy duty incidental to civil aviation produced, in his case, another epidemic of piston ring gumming—frequently attended by piston burning. These air-cooled engines were lubricated with castor oil and having had success with mineral oils in water-cooled engines, he decided to try this type of lubricant in the air-cooled ones, only to find that the higher temperature of the air-cooled cylinders reduced the viscosity of the mineral oil so much that he found it impossible to maintain the oil pressures demanded by the engine builders and had to revert to castor oil in order to maintain these pressures.

He was strongly of the opinion that these pressures could be very considerably reduced when mineral oils were used and he thought his opinion was supported by the fact that when he was using mineral oil with less than one-third of the pressure demanded by the engine builders the engines threw quantities of oil out of the breathers and the valve and tappet guides and did not display the slightest evidence of under-lubrication or ring gumming when they were stripped for overhaul. He doubted whether existing lubricating systems were designed on correct principles and he invited the engine designers and the oil technologists to review the situation and to assist him in his efforts to obtain lubricating systems and lubricants which would release the modern air-cooled aircraft engine from the trouble with lubrication which beset it immediately heavy duty was demanded of it—a trouble which could be successfully dealt with only by frequent and costly top overhauls so long as castor oils were used.

Commenting on Mr. Foord's plea that the engine designers and the oil technologists should co-operate more closely than they had done in the past, he regretted that Mr. Foord had not asked the maintenance engineer to join them, because there was no doubt that his extensive knowledge of the behaviour of the engines in service could not fail to be useful to designers of oils and engines.

Mr. E. A. Evans (Chief Chemist, Messrs. C. C. Wakefield and Co., Ltd.): Mr. Foord's statement that there is no really satisfactory lubricant, made him venture to suggest that what Mr. Foord really meant was that there is no perfect lubricant. Mr. Hall had just said he had found at least one satisfactory lubricant.

Mr. Hall: He had found more than one.

Mr. Evans: The question of carbonisation, which is almost synonymous with dirty engines, had been alluded to under the heading of " oxidation." Although some engineers are apt to make rather disparaging remarks about the chemists for not having been able to evolve helpful tests, one wondered whether the fundamental point had not been missed in considering the chemists' tests. Oxidation undoubtedly does occur in the engine. The Air Ministry has laid it down that the coke test must be carried out before the oxidation test. They are quite willing to admit that oxidation occurs in the crankcase, and apparently believe that when the oil containing the oxidised material gets past the piston rings it cokes. If it does coke in this way there should be some similarity at least between the residue which is left in the Ramsbottom tube and the carbon which is formed on the top of the piston. The ultimate analysis of a sludge which was taken from the hollow crankshaft of an engine showed that it contained 75 per cent. of carbon, 4 per cent. of hydrogen and 21 per cent. of oxygen. The deposit taken from the piston head contained 75.5 per cent. carbon, 3.6 per cent. hydrogen and 20.9 per cent. of oxygen. Therefore, there was at least some evidence—and it was more than casual evidence—that the product on the piston head was very similar indeed to the material which was formed in the crankcase. The composition of the coke which is left in the Ramsbottom tube from the oxidised oil in the Air Ministry test after coking, is 93.2 per cent. of carbon, 4 per cent. of hydrogen and only 2.8 per cent. of oxygen. Thus, there is no similarity between this material and the material which was formed on the piston head and in the crankcase. So that when one considers these questions of coking, and talks about carbon—and the President had already pointed out what a great deal of nonsense was talked about lubricating oils—one must consider the fundamental bases of one's arguments.

With regard to the cold test, Mr. Foord had stated that, generally speaking, the cold test difficulty was greater in the case of fatty oils than with mineral oils. As a matter of fact, however, the cold test of the fatty oils—*e.g.*, castor oil and rape oil—was lower by quite a considerable margin than that of the mineral oils. Castor oil had a pour test, by the I.P.T. standard method, of about $-15°$F. If the starting temperature were only round about 0°C. (32°F.), he could not imagine that the cold test alone would be sufficient for the purpose in view.

Referring to the last two illustrations shown by Mr. Foord to indicate the gumming of piston rings when a castor oil was used, he said that we must consider the question of oil feed. If the oil did not get to the piston rings there would not be any carbon or gummy material at all. It was definitely known—and it was confirmed in the paper—that mineral oil does give rise to deposits. It was stated in the paper that piston temperatures were high, and that a large amount of cooling was done by oil splash on the underside of the pistons. That was a definite indication that more oil was getting to the piston than was required for purposes of lubrication, and heat was being extracted from the piston by the oil. The author had also emphasised that the rates of oil circulation varied from 60 gallons per hour to 400 gallons per hour in engines of approximately the same b.h.p. That was a very big difference, and if one compared an air-cooled engine, such as the " Jupiter," with the Rolls-Royce " F," one found that although the oil pressure was very much the same, the oil consumption of the " Jupiter " was 16-18 pints per hour, whereas that of the Rolls-

Royce " F " was five pints per hour. He did not know whether sufficient experience had yet been gained to enable one to say that the Rolls-Royce " F," having a much lower rate of oil feed, was cleaner than the " Jupiter," but the comparison emphasised the importance of the question of oil feed in a consideration of carbonisation on the rings or at the end of the piston.

Wing Commander G. B. HYNES: One of the first points which impressed anyone who considered this matter of lubrication was the very great difficulty of testing effectively the utility or otherwise of any new oil and laid stress again on the point, already mentioned by the lecturer, of the exceedingly costly and lengthy nature of anything like a thorough test in an engine under working conditions, which however was still the only conclusive and convincing test. As an instance of the difficulties of laboratory testing, he mentioned a case in which widely varying cold test figures had been obtained in respect of the same oil tested under the same conditions by various people. A number of samples of the same oil were sent to different people for the determination of the cold test figures, and the figures obtained by the different testers had varied, not merely to the extent of 10 per cent., or even 50 or 100 per cent., but to the extent of several hundreds per cent., though the cold test was not very complicated. He believed it was specified that, certain preliminaries having been observed, the rate of flow of oil should not be less than 1 cm. in one minute. In one case the oil was reported as having moved 1 cm. in about two seconds, whilst another tester had reported that there was no appreciable movement in the period of one minute. When one obtained such discordant results from tests carried out on the same oil, and apparently under the same conditions, one was doubtful as to how far one could believe any such figures at all, and his experience emphasised the extreme difficulty of producing an oil to specification. He considered it a very good thing that Mr. Foord had raised the banner against pure castor oil. It was a great mistake that castor oil had been allowed to become a sort of complex; everybody seemed to imagine that it had magic properties which it did not really possess, or not to the extent with which it was credited. It would certainly do what was required of it well, but it had many disadvantages which had been alluded to. He had been very much impressed by the running of a foreign high performance engine in this country; it was provided with Air Ministry standard mineral oil, which was considered by those responsible for the engine as being splendid, and it had run beautifully. This fact tended to corroborate strongly the view that we had become rather obsessed with the idea that there was some mysterious virtue in castor oil, but which in fact it did not possess. With regard to " oiliness," he said he did not feel quite sure that Mr. Foord was correct in regarding the viscosity temperature curve as a sort of prime consideration and placing the factor of " oiliness " well down the list, because there was a considerable amount of evidence accumulating to show that there was some inter-relation between these characteristics such as previous speakers had mentioned. He quoted the case of a special oil that had been produced by one of the big firms for racing purposes; that oil was almost like water in appearance, but it was so prepared that the property of " oiliness " was very highly concentrated in it, and it had worked satisfactorily. The process of preparing it, as then employed, was very expensive, and therefore the oil was not one that could be used generally, but the fact that it had been produced and used successfully did indicate that we did not yet know or by any means fully understand the whole story of all the factors and complex conditions controlling efficient lubrication.

Mr. O. T. JONES (Vacuum Oil Company, Ltd.): He emphasised the difficulty of arriving at specifications which were of real use. To illustrate this, he recalled that a few years ago he had had to carry out some engine starting tests under very cold conditions, and had found that with a certain type of engine

an oil with a viscosity of about 72 Redwood at 200°F. and a cold test of 45°F. gave easier starting than an oil having a Redwood viscosity of 56 at 200°F. and a cold test of zero °F. Discussing the dirtiness of engines, he said that that trouble had been experienced in Diesel and some other types of engines and had been overcome to a considerable extent by cleaning the oil in suitable oil cleaners. In discussing this problem with aeroplane engine builders one learned that as a rule they considered it necessary to pass the whole of the oil in circulation in their engines through a cleaner, whereas in motor car engine practice it was found that if 5 or 10 per cent. of the oil were passed through a cleaner it was sufficient. The rates of oil circulation in aero engines were high, and cleaning the whole of the oil in circulation did not seem justifiable. With regard to the problem of high oil temperatures in aero engines, the very high rates of oil circulation must be borne in mind, and it would appear that the mechanical work done on the oil in circulating it through the systems at high rates has a great deal to do with the high temperatures. The high temperature of the oil was perhaps due more to this cause than is generally believed. It seemed rather a fallacy to circulate oil at very high rates, therefore, when we had to admit the difficulty of cooling the oil in a cooler, and if it is found practicable to reduce the quantity circulated per hour the advantages would be considerable. He asked Mr. Foord whether his figures representing the quantities of oil circulated included only the oil which passed through the bearings of the engines, or whether they included also that which passed through the relief valves. With regard to sludging, he mentioned a case in which bad sludging had been experienced in a turbine installation, which had been largely overcome by rearranging the tank and oilpipe system in order to reduce the amount of turbulence and aeration of the oil in circulation. The trouble in that case, therefore, was mainly in the tanks and pipes and not in the turbine itself. He was glad to note that Mr. Foord had mentioned the need for modification of the design of oilways. This was a matter for the engineers rather than the oil producers. He inquired whether it was possible to pass the return oil from the engine over a plate or "umbrella" to give the air an opportunity to separate foul and thus reduce the oxidation effects to some extent. He was in agreement with Mr. Foord with regard to the objections to the graphiting of oils. He asked if it were possible to introduce more ventilation into aero engine crankcases, because in other internal combustion engines the lubrication conditions had been improved considerably by making provision for a reasonable, but not excessive, circulation of air in the crankcases, and the oil consumption had also been reduced substantially thereby. Finally, in reference to the bench tests carried out by Mr. Foord, he asked if they had been followed by tests of long duration in the air, because in other spheres, and no doubt also in connection with aircraft, test bench conditions were very different from practical service conditions from a lubrication standpoint.

Mr. A. F. Evans: Some fifteen years ago he had been responsible for some engines which had had to work for many hours at full load, and he had tried to find a specification for lubricating oil for these engines, but had failed. Therefore, he had evolved some very crude tests for the purposes of comparing oils. In one of these tests samples of oils were placed in test tubes which were heated to a temperature of 500°F., and maintained at that temperature for 200 hours, and this was done in a small oven with thermostatic control. The viscosity of the oil and the evaporation were then ascertained, and though he was dealing only with the very highest quality oils he could obtain, irrespective of price, while in some cases the oils after test were black and fluid, there having been very little increase in viscosity; in many other cases the oils were like pitch. In the case of some special oils, which were sold as racing oils, the resultant resembled samples of synthetic rubber and the test tubes had to be broken off

the content. He asked Mr. Foord what value he attached to such a test; he himself had found it of value.

The greatest trouble he had experienced in lubrication was the gumming up of the piston rings and the carbonising of the oil behind the rings. There was, however, no air behind the rings to cause oxidation. He suggested that in a bearing the factor of importance was that of the extrusion of the oil. If we had a piece of apparatus whereby the oil could be placed between two surfaces, and subjected to a given pressure at a given temperature, and if there were an electrical circuit between the two surfaces, in a given time we should get extrusion of the oil film and there would be contact. Would this time element depend exactly on the viscosity of the oil? He doubted it. Finally, discussing the problem of dopes, he recalled that on the stall of some chemical manufacturers at the Shepherd's Bush World Trade Exhibition he had noticed a nice white-looking powder, the purpose of which, it was stated, was to increase the viscosity of oils. Did Mr. Foord know anything about that?

Flight Lieutenant C. H. POTTS: It was considered possible with the present state of knowledge on oil to draw up a specification for an oil which would be suitable for all service engines to meet both winter and summer conditions.

With regard to the temperature of oil, the rates of circulation appear to be a most important point, inasmuch as it is found to be extremely difficult to cool the oil in engines which have a high rate of circulation. The air-cooled engine had a rate of circulation of 60 gallons per hour and was found to be quite easy to cool, but the water-cooled engine, having a circulation of over 400 gallons per hour, was extremely difficult to cool. It has been suggested that removing the air from the oil when passing from the scavenger pump to the oil tank would help to cool the oil. This has been tried, but no advantage was obtained.

Oil cooling in all modern engines is found to be very necessary and the chief point affected is the piston, as experience has shown that on service engines no trouble has occurred due to the failure of either journal or crank pin bearings due to high oil temperatures, but frequent overhauls have been necessary due to the carbon forming on the piston, and this trouble is experienced as much with the water-cooled engine as with the radial air-cooled engine. It would, therefore, seem desirable to know what the temperature of the cylinder, the piston, or the oil is on various types of engines, both water and air-cooled, but judging from the temperature of the water recorded on a water-cooled engine which controls the cylinder temperature and is usually 75°C. ±5, and the air-cooled cylinder temperature which ranges from 220—300°, the heat of the oil from the cylinder or piston does not appear to be of first importance.

The other important factor is the oil consumption. This varies considerably on different types of engines of the same horse-power, but not of the same type, the water-cooled engine having a much lower consumption than the air-cooled. This may be due to the cylinder temperature or to the unequal cooling of the cylinder in the air-cooled engine. He was assuming that the oil consumed is that which passes the piston only and not the crankcase breathing, etc. If this is correct, more attention is required to the effective methods of scraping and piston ring clearances.

A further point which seems to affect the overhaul life of the aircraft engine is the fuel used and the consumption, as experience has proved that heavy fuel consumption is a frequent cause of reducing the overhaul life of the engine, due to the same cause as previously mentioned of carbon on the pistons.

Another important point in connection with increased life of the aircraft engine is starting the engine in the cold weather. In the past no provision has been made to keep the oil warm or the engine, with the exception of having a partial circulating device in the oil tank in order to circulate a small quantity

of oil when starting the engine, in order to raise the temperature quickly. This does not fulfil all that is considered to be necessary, as the oil in the engine, the filters and the pipes may be congealed and before a proper circulation can be obtained through the oil system, the damage has been done in most cases to the bearings in the water-cooled engine, and in most cases with regard to the air-cooled engine to the piston and cylinder.

The centrifuging device mentioned is undoubtedly a very desirable factor for all aircraft engines, as it is considered that the present types of filters used are inadequate for extracting all the necessary dirt and foreign matter from the oil.

Wing Commander MAUND: If the oil producers and engine designers were to co-operate, they ought also to co-operate with the users of the engines from time to time in order to ascertain what the real troubles were in practice. The problem of starting was of vital importance; much damage could be done to engines during starting. It had been said that one hour's running-up on the ground was more destructive than twenty hours in the air, and he believed that to be quite a modest estimate in cold weather. One type of engine of which he had experience, and in connection with which very effective methods were applied for heating the oil rapidly, ran for a longer period between overhauls than any other he knew of.

Mr. BOWREY: Some metals had a deteriorating influence upon the oils used. By some action not fully understood, the presence of metal in contact with mineral oil caused oxidation to take place at an increased rate. For example, the same oil heated in glass vessels in the presence of air, with or without metal present, had been found to yield the following amounts of sludge:—

Metal present.	Percentage sludge formed to total weight of oil.
	%
None	0.06
Aluminium	0.05
Tin	0.05
Zinc	0.05
Nickel	0.06
Mercury	0.08
Steel	0.13
Silver	0.15
Copper	0.29
Lead	0.43

The surface area of the metals and the conditions of the test were the same in each case. It would be observed that aluminium, tin, zinc and nickel were inactive, whereas copper was exceedingly harmful, increasing the formation of sludge by five times. Lead was found to be actually dissolved by the oxidation products of the oil, but since its use in engines was generally confined to lead alloys, where it was protected by inert metals, its effect was perhaps of less importance than that of copper.

The effect of increasing or reducing the area of an active metal was to increase or reduce the rate of sludge formation, as would be seen from the following comparison:—

	Sludge.
	%
Oil alone	0.06
With one square inch of copper per gallon of oil ...	0.20
With 275 square inches of copper per gallon of oil ...	0.29
With 1,500 square inches of copper per gallon of oil ...	0.41

In view of these facts he asked whether more attention could not be given to avoiding the use of exposed copper surfaces in lubrication systems—for example, by tinning them wherever possible. This measure, if thoroughly carried out, would clearly have a beneficial effect in delaying the formation of oil sludge and increasing the period between overhauls.

Mr. T. Kenneth Young, A.M.I.Mech.E.: As a brief reference has been made to Dr. Acheson's colloidal graphite, both by the author and the chairman, and as he was the only representative of Dr. Acheson's English Company to be present at this meeting to-night, he felt it incumbent upon him to say a few words regarding the subject of graphited lubricating oils.

Firstly, Mr. Foord had alluded to " the bugbear of carbon deposit " following the use of graphited oil. In this connection he thought it only fair to remember that the following factors have to be borne in mind:—

(*a*) The percentage of colloidal graphitic carbon present in the lubricant.
(*b*) The type of oil adopted as the colloid medium.
(*c*) The class of oil with which the colloidal graphite is mixed.
(*d*) The method and thoroughness of mixing.
(*e*) The amount of this graphited oil fed to the engine.

If any or all of these points are given too scanty attention carbon might be expected to accumulate, but he thought that Mr. Foord in his remarks was referring to certain tests made some ten years or so ago. In the meantime considerable progress has been made.

Secondly, the President spoke with some enthusiasm about the possible value of Dr. Acheson's colloidal graphite, but expressed the view that the particles might not always be in a true colloidal condition.

His own comment upon this would be that a true colloidal condition can be attained and maintained if due thought is given to the selection of the oil with which the " oildag " is mixed and the method of mixing.

Difficulties there undoubtedly are, but they are certainly not insuperable. As such intelligent interest is now being given to the subject of lubrication, both by lubricating oil concerns and the users, there is every reason to expect that Acheson colloidal graphite will, as time goes on, become more useful to those associated with aero engine lubrication.

The President and others referred to the extravagant statements made in reference to the qualities of various lubricating oils; perhaps this remark is more particularly true regarding colloidal graphite because of its unusual qualities, but he would like to take this opportunity of suggesting that such statements are largely traceable to enthusiastic users who are unable to account for the good results they have obtained, but in spite of this wish to impress others. He thought that any of those present who have come into intimate contact with members of Dr. Acheson's organisation will be ready to admit that all statements they have made with regard to colloidal graphite lubrication are if anything on the conservative side.

As directing some light upon the way in which colloidal graphite can be useful, he would like to refer to one or two applications which came to his mind at the moment.

Mr. Foord referred to the fact that considerable friction in an aero engine took place after it has been standing, during which time the oil film had been squeezed and drained out and metal surfaces were in contact until the circulating oil reached the spot.

Now if a " graphoid surface " had been formed on cylinder walls, etc., it seemed to him that there would be no such abrasion since the graphite would act as an adequate lubricant even though there were no oil present. Proof of this statement can be given if necessary.

Another speaker referred to the life of an aero engine which had now been increased to 500 or 600 hours from a figure of 100 hours, which at one time was thought to be a good one; but surely even 500 or 600 hours leaves much room for improvement, and as Mr. Foord admits that the use of colloidal graphite offers some benefits as regards bearing life (under which heading he doubtless includes cylinders), he therefore submitted that this subject deserved some further investigation if one was to increase engine life.

Then there is the question of safety, and speaking with some years of flying experience during the War, he could say that he felt every pilot would welcome the introduction of a lubricant which would give him a chance of getting " home " even though an oil pipe were fractured and his engine was getting no fresh supply of oil. With a " graphoid surface " formed as a result of using a graphited oil, this would be possible.

There is not the slightest doubt that the subject of colloidal graphite is always one of interest. This is evidenced by the fact that others in addition to the lecturer and the President have referred to it at this meeting. Might he ask those to whom this question does appeal to maintain their interest, for just as aviation had taken some years to develop, so an important advance of this nature cannot be expected to reach perfection until some time has elapsed. It may be a year or two or even longer, but undoubtedly as a result of active co-operation between the manufacturers of " Oildag," the leading oil concerns, builders of engines and the service and civil aircraft organisations, he felt sure that the value of graphited oil in this sphere will be appreciated, and he hoped it would be his privilege to give some definite information regarding this subject on another occasion.

Mr. A. H. R. Fedden: It is very necessary that there should be closer co-operation between the oil technologist and the engine designer with a view to standardising the methods of taking the analyses of oils and reporting on the condition of oils after test. Standard methods are laid down for testing metals, and if an aero engine designer received particulars of some new material he can investigate the standard specification of it and can readily make a mental comparison between this new material and existing materials of a similar class. These conditions do not exist with oils. Specifications and methods of testing vary considerably and it is impossible to compare one oil with another until all oil testing methods are brought to a common basis. It is considered that the time is now ripe for a round-table conference on this question with the oil and engine manufacturers.

He was entirely in agreement with Mr. Foord's views in respect to mineral oils, and with this object in view the Bristol Company have had three separate 100-hour tests, under official observation, on different brands of mineral oil with standard " Jupiter " engines, during the last nine months. In every instance the strip of these engines has been excellent, and the wear and bearing surfaces at least as good, and in some instances better than with pure pharmaceutical castor oil.

He did feel, however, that the question of sludge and the filling up of oilways required further consideration, and this he considered could only be proved out by a very extended test of 400 to 500 hours without stripping down or disturbing the engine.

Personally, he was rather against mineral oils with too high a viscosity because this quality was almost sure to mean that some ingredients had been introduced into the oil to bring up the viscosity which are not satisfactory in other respects. Apart from oil consumption difficulties, he did not see any difficulty in using a thin oil from a bearing and wear point of view. The Bristol Company had just completed a 100 hours test with a " Jupiter " engine on P.4 mineral oil with the oil temperature returning to the engine at 85°C. Naturally

with this temperature a mineral oil is very thin, but no deleterious effects had been found on the engine.

Also with very thin oil the oil pressure must be reduced to bring back the oil return to the same as it is with a higher viscosity vegetable oil, and the pistons want watching.

The Bristol Company had recently carried out an endurance flight test with low viscosity oil on an old engine which had been in use for some years. It was found that oiling up of the plugs was experienced with this oil, whereas with ordinary pharmaceutical castor oil no trouble was experienced. This would lead one to think that on an old engine, when things are getting pretty loose, greater difficulties may be experienced with mineral oil with oiling up of plugs and oil leaks.

He was of the opinion that some of the complaints levelled at certain brands of oil are due to faulty design of oil pumps, or oil relief valves, causing frothing and extensive oxidisation, or drop in pressure.

He agreed with Mr. Foord in his remarks regarding oil pressure. He was greatly adverse to high oil pressure and considered that with reasonable design it was quite unnecessary. Low oil pressure certainly gave the pilot more confidence, and although he knew his remarks would not be accepted in official circles, he was quite convinced that the right oil pressure for an aero engine with mineral oil was a varying one, *i.e.*, a high oil pressure when the engine was cold, dropping down to a lower level when the engine was warmed up and running under normal conditions. A varying oil pressure would give the aero engine designer a much greater latitude in the design of pump, relief valve, oil returns, etc.

Mr. Wm. Lee (Chief Chemist, Silvertown Lubricants, Ltd.) (*communicated*): He would like to emphasise the recognition of the important part played by oxidation of lubricating oil in the crankcases of internal combustion engines. The black powder which, with unchanged oil, forms the well-known mud in petrol engines, including aircraft engines, and in Diesel engines, is an oxidation product; the temperature is not high enough to cause destructive distillation with deposition of carbon. This oxidation is done at a much lower temperature, and takes place in the comparatively small amount of oil which exists partly as spray and partly as oil-fog. In this extremely finely divided condition, the attack of the oxygen is accelerated and, either by direct heat from the walls of the piston or by radiation, the fog is rapidly oxidised, partly to asphalt, but much of it, particularly just under the piston, to the further black insoluble state.

Although analyses by different chemists do not agree, all show the presence of oxygen, and those made under the direction of the speaker show up to 20 per cent. of oxygen and 0.5 per cent. of sulphur. (The latter is higher than the amount in the oil, so there appears to be a concentration of the sulphur in the carbon and asphalt.) Oxidation of the oil in circulation only takes place to this stage piecemeal.

The main bulk of the oil is at a much lower temperature and oxidation takes place at a very much reduced rate. If the black insoluble portion be filtered off, the presence of oxidation products in the oil is easily detected; in some cases *considerable amounts* of resinous and asphaltic substances are present. Along with the black " carbon " varying amounts of asphalt are found; this being soluble in benzole, is easily separated. Seeing that whatever type of oil is put into the crankcase, this black carbon is produced, the validity and utility of the Air Board Blowing Test are frequently questioned. That the blowing test is of real value in showing the relative stability of oils cannot be denied. The obscurity is due to the fact that as the temperature of a blowing test is increased, different oils approach one another in the rapidity of oxidation. The oil-fog is turned to a tar-fog, and the quantity formed depends more on the

temperature and the amount of air than on the particular type of hydrocarbon. In the cooler parts of the fog, resistant oil remains unattacked or only partially attacked, whereas a non-resistant oil is attacked in a larger volume, *i.e.*, to a greater distance from the underside of the piston. The comparatively cool bulk of the oil in fluid circulation indicates a steady oxidation exactly in accordance with its blowing factor, and it is the fact of high consumption which saves the non-resistant oils. The time any given volume of oil remains in circulation is short, it is soon dissipated through the combustion chamber, and lost before very serious deterioration can occur. This question of high consumption must be, and will be, dealt with presently, and when reduced to a reasonable rate corresponding to that of road motor or even small Diesel engines, the importance of resistance to oxidation will be imperative.

Recent engine trials have shown that by far the dirtiest crankcases were produced by heavy distilled oils of poor resistance to oxidation. Every care was taken that the distilled oil should be the best of its kind, and when it is known that its viscosity at 200°F. was equal to that of castor oil, that its coke value before use was under 0.2 per cent., and that its blowing factor was as low as 2.2 as compared with the usual figures of double this size, it is clear that the type was given every opportunity of doing its best; yet the whole of the mechanism of the crankcase was heavily coated with carbon, and the oil was carrying round with it double the quantity of solid matter usually in circulation.

Objection might be raised to the high temperature of 200°F. for oxidation, but a series of oils blown at temperatures from 200°F. down to 150°F. came out in the same order in every case and, moreover, the same oils when placed in closed bearings and run until incipiently failing through oxidation, gumming and thickening, the order was exactly the same as that of the blowing tests.

Undoubtedly the test has its defects, but instead of raising so much criticism against it, more suggestions are called for in the way of improving it, correlating the results with those in practice, and more searching for the reasons for apparent contradictions. An oxidation test is of great value and gives incontrovertible evidence of the stability of an oil, and it cannot be dropped until a better test is brought forward.

It should be noted that the Ramsbottom test results in the oxidation of a small portion of the oil only, and that the coke obtained must of necessity contain a low percentage of oxygen. A large quantity of the carbon obtained in the bulb test must be from unoxidised or partially oxidised oil. It should also be noted that the whole of a mineral can be oxidised, and if the test were prolonged no unchanged oil would remain. In an imperfectly refined oil there is a small percentage which is extremely unstable and oxidises rapidly. After that, a steady oxidation, bit by bit of the whole of the remaining oil proceeds.

Messrs. Callandar, King and Mardles have made what appears to be a very valuable contribution to the question of preventing crankcase oxidation. They point out that certain materials have an anti-catalytic effect which results in either preventing or side-tracking the oxygen attack. With the anti-catalyst present, an oil will remain clean and bright for a long time, whereas without it the usual blackened condition rapidly appears. In addition to this the amount of carbon on the piston side is greatly lessened and its nature altered. The oil, not having been oxidised in the crankcase, does not go through such a gummy, pitchy condition before finally carbonising. The carbon is not so adherent but is loose, and it would appear that some substances have the property of altering the line of cleavage during destructive distillation, so that more carbon comes off in the form of distillable compounds and less free carbon is produced during the decomposition. The importance of this cannot be overlooked and it opens up a very interesting line of research, seeing that engine designers at present, at any rate, are unanimous in stating that the problem of keeping air out of the

crankcase presents insuperable difficulties. The point should be gone into by engineers, of the desirability in every case of avoiding contact of heated oil with air, and of reducing splashing and spraying to a minimum.

Wing Commander T. R. CAVE-BROWNE-CAVE (*communicated*): The problem of lubrication as applied to airship engines is somewhat special in that provision must be made for flights of 50 hours and more.

The oil cleaner which is described appears therefore to be better justified in an airship installation than in an aeroplane. He was not clear, however, that the importance of removing dirt, even during a 50 hours' run, was sufficient to justify the provision of this special fitting. Any data which would establish the necessity of removing this dirt would therefore be of interest.

The centrifugal cleaner had the additional advantage that it discharged oil over the inside of a surface, the outside of which is exposed to the airflow. This could, however, be done by a very much simpler arrangement of sprays.

The author drew attention to the oxidation of the oil produced by the air which is drawn by the scavenge pump. If this oxidation were serious it appeared undesirable to aerate the oil still further by any formation of spray. The whole objection seemed rather doubtful, however, in view of the very large amount of spray and the very large surfaces exposed in the crankcase.

The information about the various types of oil cooler appeared incomplete. No figures were given for the actual quantity of heat removed or the drag caused by oil coolers of any type.

The coking of oil was governed presumably by the temperature of the piston and liner. The author suggested that evaporative cooling would aggravate this. The evaporative system did not appreciably increase these temperatures and they were not nearly so high as in an air-cooled engine.

The increase in temperature of oil delivered to the engine should have little effect on coking. It is understood to be undesirable that oil should be delivered to the engine at a temperature above 100°C. The reasons for this were not very clear and it was pointed out that if it were possible to design the bearings and to obtain an oil which would work satisfactorily with delivery temperatures somewhat over 100°C., the problem of oil cooling could be very simply met by using the circulating water as the cooling medium. It seemed therefore desirable to determine exactly what are the reasons for which this higher oil temperature will be unsatisfactory.

An incidental point which he had raised previously might be worth mentioning. The position in which oilways are made in big-end bearings varied considerably. It is usually such that a part of the most heavily loaded area was removed and the adjacent white metal given a chance of shearing into the oilway. If, however, the oilway was arranged at the butts of the bearing, the load there was a minimum and the position appeared best both from the point of view of introducing the oil and preventing the shear of the bearing metal.

REPLY TO DISCUSSION

The President refers to the importance and complexity of the problem of aircraft engine lubrication and to the interest this paper has aroused amongst all concerned. This latter is a very gratifying sign of the times and is exactly what is required in order that the various branches of the aircraft industry concerned should co-ordinate their activities in the direction of improvement in efficiency and reliability of lubricating systems.

He mentions tests at Bristol on an old "Jupiter" engine with mineral and castor oils and the comparison as regards oiling up of plugs in favour of the latter oil.

Mr. Fedden, in his written communication later, also mentions these tests and incidentally supplies the clue to the trouble. It will be noted that the mineral

oil utilised was a low viscosity oil whilst the standard pharmaceutical castor oil was considerably higher in viscosity.

The trouble, it is considered, is purely a mechanical one of piston sealing, the leakage past the rings being greater in the case of the low viscosity mineral oil than with high viscosity castor oil. Consequently the plugs have more oil to cope with in the former case than in the latter. Such troubles are the province of the aircraft engine designer and have little, if anything, to do with the nature of the oil used—other things, *e.g.*, viscosity, being equal.

It is thought that as far as plugs are concerned mineral oil is slightly better than castor, inasmuch as the former oil will evaporate off more readily and not gum and clog the points like castor displays a tendency to do.

As regards length of tests for comparative purposes the 100 hours has been mentioned as this is the standard service type test on the bench, and I am in entire agreement with the necessity for prolonged endurance tests before being satisfied that mineral oil is satisfactory.

I think, however, Mr. Hall supplies all the necessary evidence we require in this direction, when referring to mineral oils he states that " many thousands of hours of flight had failed to produce a single gummed ring or appreciable loss of power between overhauls."

The question of oil cleaners is of particular importance and a large number of attempts have been made to solve the problem, but there is one factor which has to be faced on the aircraft engine which does not trouble the designers of other forms of prime movers and that is weight. It would appear that at present in order to obtain efficient cleaning for a minimum weight the high speed centrifugal type of cleaner is the only possible line of attack.

The static type of cleaner, such as the Hele-Shaw streamline flow filter, is a most efficient cleaner, but weighs at least eight to ten times as much as the centrifugal type for the same duty.

The President's remarks on graphite in the colloidal form are largely answered by Mr Kenneth Young and I will refer later on to this; but as regards the suitability of graphite for valve guide lubrication, I agree entirely with his statements. It is pointed out, however, that this is a case by itself and has little bearing on the general question of suitability of graphited oils for bearing and cylinder lubrication.

In one case we have a comparatively cool reciprocating valve stem with no continuous flow of lubricating medium and graphite comes into its own under such conditions.

In the other case the question of continuous flow of oil through small oil holes, oilways and fine clearances, and the absolute necessity for prevention of blocking of such by sludge, in addition to the question of carbon on piston crowns and rings, all combine to prevent the use of graphite, *i.e.*, of course in its present form.

Dr. Dunstan's remarks are of the greatest interest coming as they do from so eminent an authority.

On the question of oiliness, however, I fear he is somewhat under a misapprehension as there is no question of lack of faith in the property and importance of oiliness. The point made in the paper is that where a comparison between fatty oils and mineral oils of similar viscosity is being made for this particular function of lubricating aircraft engines, the slight difference in the oiliness factor is negligible when compared with the other factors which have to be taken into consideration and upon which stress has already been laid.

Mr. Kewley's remarks on this point are relevant, viz., that differences in oiliness are only of the utmost importance under limiting conditions of lubrication, a state of things which it is hoped few aircraft engines have to cope with.

Dealing with Dr. Dunstan's remarks and quotations regarding oxidation and coke tests, it is of interest to note that a series of engine tests carried out by the Air Ministry on different types of mineral oils, demonstrated that as regards general suitability of an oil for aircraft engine lubrication, these laboratory tests placed the oils in an order of merit which was confirmed by the practical tests.

It is not claimed that the tests in their present state represent the last word, but it appears to have been thoroughly demonstrated that if we are to have laboratory tests of any practical value, this line of attack is certainly promising.

Mr. Lee's remarks on this question of oxidation tests are of the utmost importance and demonstrate how improvement in this respect can be obtained.

Finally, I am sure Dr. Dunstan is not so pessimistic regarding the value of laboratory tests in controlling the quality of a lubricant as his last query would lead us to believe!

Mr. Pye stresses the importance of lubrication research generally and draws attention to the fact that at any moment some scientific discovery may be made which would entirely alter our ideas on lubrication.

I agree with him entirely, for if there is one phase of scientific engineering of which we lack knowledge, it is the mechanism of lubrication.

One has only to think of the tremendous revolution brought about in marine engineering circles some years back by the evolution of the Michell thrust block and the wonderful changes wrought thereby, to consider a case in point.

He illustrates the difficulty of co-ordinating laboratory and engine tests by quoting a case of engine tests which apparently directly contradicted the laboratory forecasts.

I strongly suspect that the engine tests concerned were single cylinder tests and that if prolonged tests had been carried out on a complete and representative engine under actual running conditions the conclusions might have been quite different.

The reason for this is that conditions regarding atomisation and oxidation of the oil may be quite different in the two cases.

I agree with him, however, that oils are tricky things and that in the present state of knowledge it is necessary to display caution in trying to forecast results. This however, is only an argument for more intensive research in order that the laboratory may be in a position to carry out tests of a nature which will enable an assurance to be made that suitable oils can be selected.

Mr. Pye also raises the query regarding which constituents of an oil are oxidisable.

Mr. Lee deals with this point and his evidence is that the whole of a mineral oil can be oxidised if the test is carried far enough, until no unchanged oil remains, a statement in support of which there is undoubtedly plenty of practical evidence.

Mr. Kewley's difficulties in trying to produce all the ideal characteristics put forward with the restricted natural materials available are thoroughly appreciated, and I agree with him that the engine designer has got to go further in the direction of modifying his engine to suit the available oils.

I think a large amount of work in this direction is already in progress and I visualise the time not far distant when aircraft engines will be able to run on oils which at present are frowned upon.

His remarks on oiliness get right down to the root of the matter and I am in entire agreement with them.

Mr. Hall's evidence in favour of mineral oil is of the utmost importance, as he is in the unique position of being able to judge on a large scale the results of the co-ordinated efforts of engine designer and oil technologist.

I agree with him most emphatically that the maintenance engineer should be brought into consultation on these problems, as it is the life between overhauls that is the primary evidence of a satisfactory lubricant.

He speaks of lowering oil pressures when using mineral oils. This can undoubtedly be done provided the capacity of the oil pumps is adequate to maintain the necessary oil flow. in fact, I think it would be an advantage to do so.

As regards his remarks on design of lubricating systems, there is undoubtedly plenty of room for improvement, and I look to the awakened interest in this problem on the part of the engine designers to help us in that direction.

Mr. E. A. Evans appears to have very grave doubts as to the efficacy of the chemist's tests for indicating what is likely to happen in the engine, and states that in order to avoid talking nonsense " we must consider the fundamental basis of our arguments."

Let us proceed to do so!

Taking his first point regarding the difference between the deposit in the engine and that in the coking test, he draws attention to the difference in chemical composition and gives figures showing the greater percentage of oxygen in the engine compared with that in the residue after coking.

Surely the reason is obvious—in the case of the engine his residue is sampled after an endurance test, probably 100 hours or more, during which the oil has been thoroughly atomised and mixed with air and the oxidation has been carried to the probable limit.

In the case of the coking test, this is carried out after a twelve hours' blowing test during which air is bubbled through a test tube and the amount of oxidation is therefore limited.

Nevertheless, the test is an indicator of what happens in the engine, it is only limited in duration for practical purposes in the laboratory, and as Mr. Lee points out later, if you carry the oxidation far enough, eventually the whole of a mineral oil will be oxidised and concordant results on analysis of residue will be obtained.

Mr. E. A. Evans then proceeds to discuss the relative results with castor and mineral oils as regards gumming and tries to explain the difference in the two pistons shown in the paper on the basis of difference of oil feed.

Whilst I agree that as between different types of engines the rate of oil feed may influence the general consideration of dirtiness and carbonisation of rings and pistons, he misses the point made in this case, viz., that the tests in question were done on the identical engine and therefore the only difference is the nature and quality of the respective oils used.

As regards cold test difficulty the important point is that round about $-0°C$. the viscosity of castor oil is so much greater than that of mineral that for starting up purposes the time lag before the oil reaches important bearings in the case of castor oil is a serious drawback and causes undue wear, besides increasing by a considerable amount the warming up period before a machine is able to get off.

Wing Commander G. B. Hynes describes the difficulties experienced in obtaining concordant results in various laboratories on a cold test with samples of the same oil. I sympathise with him heartily; but I think his statement that the tests were carried out " *apparently under the same conditions* " gives us a clue to the solution of the difficulty.

The remedy is to tighten up the details of the laboratory test in order to ensure that the conditions are identical.

The evidence in favour of mineral oil is valuable particularly relating as it does to foreign practice.

With reference to his remarks on oiliness, I agree with him as to its importance when considering the question from an absolute point of view and the replies to Dr. Dunstan and Mr. Kewley on this point are relevant here.

Mr. O. T. Jones draws attention to motor car practice as regards cleaning of oil, and states that it does not seem justifiable to clean the whole of the oil in circulation as is done with aircraft engines.

This appears to be a question mainly of degree and differences in the lubrication system.

If the whole of the oil in the car engine were cleaned the useful life of the oil and the period between replenishments of the sump would be thereby lengthened.

Incidentally, of course, the car engine uses a wet sump and the aircraft engine a dry sump. In the latter case the whole of the oil is circulated continuously and it is therefore convenient to clean it in bulk, moreover due to the higher duty demanded of the oil and the short life between overhauls it is more necessary.

The idea of more ventilation of crankcases would be detrimental from the oxidation point of view, in fact it is desirable if possible to reduce the amount of air in contact with the oil for this particular reason.

The figures of oil circulation given in the paper are those of the pump capacity and of course include the oil passed by the relief valve.

The point made regarding the heating of the oil by the mechanical work done on it in circulating through the system at high rates is relatively unimportant compared with the amount of heat given to the oil in the hot bearings and by hot pistons.

Finally, it is always the practice to carry out extensive air endurance tests on aircraft engines in addition to bench tests before approving any oil for widespread use.

Mr. A. F. Evans' remarks on his experience with testing of oils are of interest. His particular method of heating samples of oil in an oven is much akin to the standard coke test adopted by the Air Ministry and should give roughly the same comparative results.

The difference in behaviour of the various oils under his test is understandable, the racing oils he refers to as giving a residue like synthetic rubber were apparently oils with a fatty base similar to castor, this being a characteristic of such oils when coked.

He discusses the importance of the extrusion factor of an oil in a bearing and asks whether this is dependent exactly on the viscosity. The viscosity has a large influence on this question, but there are factors such as the nature of the bearing metals and adhesiveness or "oiliness" of the particular oils concerned which are more important when considering such a property of oils.

Finally, he mentions a powder which would influence the viscosity of an oil. I must confess I do not know of such a powder which would serve any useful purpose from a lubrication point of view. This appears to belong to the numerous get rich schemes which are ofttimes sprung on the "unsuspecting user."

Flight Lieutenant Potts' remarks are of interest, coming as they do from one who is vitally concerned with the results obtained in service.

In discussing the question of temperature of oil, he states that "the heat of the oil from the cylinder or piston does not appear to be of first importance," and gives as his reasons the fact that water-cooled engines have water-jacket

temperatures of 75°C. ± 5, whilst air-cooled cylinders have cylinder temperatures of 220°C.-300°C., and there appears to be no difference in the respective types as regards piston carbon and life between overhauls.

I would draw his attention to the fact that although the water temperature is only 75°C., this is not of necessity a reliable criterion of the actual piston and cylinder temperatures in this class of engine. It may well be, and probably is, the case that the piston and cylinder temperatures in both water-cooled and air-cooled engines are in excess of 220-300°C. and therefore the heat to the oil from these parts is of primary importance.

As regards the question of oil consumption, there is considerable room for improvement in piston sealing methods, such improvement would reflect lower as regards piston carbon and life between overhauls.

The question of starting engines under cold conditions has already been referred to in the reply to Mr. E. A. Evans.

Wing Commander Maund's remarks are covered by previous replies; but his experience of heating oil for starting purposes is corroborative of the necessity for quick circulation of oil which has previously been emphasised.

Mr. Bowrey's theory of the influence of different metals on the rate of oxidation is of great interest, particularly when referred to copper. He does not say how the temperature affects the rate of oxidation with the different metals; this is of importance and one would imagine the large differences described are minimised with low temperatures. Copper pipes are used largely in the lubrication system and tinning would be possible; but the oil in these pipes is always below 100°C.

Mr. Kenneth Young speaks of the use of colloidal graphite and draws attention to the difficulties to be encountered in ensuring a true colloidal condition with the various types of oils in use.

I agree with him that if a true graphoid surface could be ensured, then the advantages from a cold starting point of view and also in case of a lubrication system failure would be worth having; but this is presupposing the corresponding disadvantages of carbon deposit and separation can be got rid of, an assumption which seems to be doubtful.

It is perfectly certain that extensive use of graphited oils for aircraft engine work cannot be made until the disadvantages described can be overcome and until any type of oil normally used can be graphited satisfactorily and the latter can compete on the score of price and availability.

To this end I welcome further investigation into the subject and agree that it is a matter requiring active co-operation between the various interests concerned.

Mr. Fedden, speaking of oil specifications, urges the necessity for standardisation of such specifications and their methods of testing and draws an interesting comparison with metals in this respect.

The standard methods of test already exist; but the standard oil specification will never materialise until the aircraft engine designer and user get together and make up their minds what they really require as regards oil characteristics.

In the case of metals, the engine designer specifies certain known and standardised properties and designs accordingly; but in the case of oils he is all at sea and the primary object of this paper was to try and clear the air a little on such points.

The discussion, however, is sufficient evidence of the great variation in views, although it has gone a long way to emphasising the salient features.

Mr. Fedden's evidence on his experience with mineral oil is valuable; but his contention as regards life between strip has already been answered by Mr. Hall.

Incidentally, recent tests have shown that engines can be run over 500 hours between overhaul without trouble whilst using mineral oil.

His experience with oiling up of plugs when using low viscosity mineral oil I have already referred to in my reply to the President.

I agree that low viscosity oils can be utilised, but such troubles as high oil consumption, improved piston sealing, oiling of plugs, have all to be cured before this can be considered a practicable proposition.

There appears to be no reason why one should not have a variable oil pressure, in fact this is surely what actually happens in practice. What Mr. Fedden really wants is a lower minimum pressure which would give him the design latitude he requires.

Mr. Wm. Lee's contribution is an extremely valuable one and gives us the sort of evidence that is required as to the efficacy of the oxidation test. It is interesting to observe that after a considerable amount of experience he is definitely of the opinion that the blowing test is of real value in giving us an indication of the relative stability of different oils. I agree with him that the details of the test could probably be improved, and this is the subject of further work; but the main thing is that the principle adopted is on the right lines.

He speaks of the necessity of reducing the oil consumption. This is mainly a mechanical problem which is not so easy to solve, particularly in the case of radial engines; but work in this direction is proceeding and promising results are already being obtained.

In discussing the question of preventing crankcase oxidation, he stresses the necessity of avoiding contact of heated oil with air and of reducing splashing and spraying to a minimum.

This is a very difficult problem indeed and seems almost insuperable, at any rate, whilst the existing ideas of aircraft engine design prevail.

Wing Commander Cave-Browne-Cave seems to have doubts as to the necessity for providing special means for cleaning the oil, even in airships with their long endurance flights. I can only reiterate the arguments put forward in the paper, viz., a considerable increase in the life of bearings between overhauls and a lessened likelihood of failure of such bearings due to impurities, metallic and otherwise, in the oil, all of which are surely desirable. A cleaner is a small price to pay for such a return and there is ample evidence as a result of flight tests that the cleaner described or any other equivalent type does do the job of eliminating such impurities.

As regards the question of oxidation I would draw Commander Cave's attention to Mr. Lee's remarks which show the importance of this question on the deterioration of oils.

I agree that the cleaner described does atomise the oil in order to cool it; but this is done under much better temperature conditions in the oil tank than is the case in the engine and therefore the oxidation effect is minimised.

As regards the question of drag of oil coolers, I am sure Commander Cave would be the first to appreciate that the drag of such a cooler relative to that of a machine as a whole is so small as to be difficult to measure.

Referring to the lubrication difficulties with evaporative cooling, a case in point is a well-known aircraft engine which normally ran on castor oil as a lubricant, but absolutely failed to do more than a few hours with that oil when

converted to evaporative cooling. Consequently mineral oil was tried with every success. I think this undoubtedly points to higher cylinder and piston temperatures with evaporative cooling.

I am afraid I cannot agree that increased temperature of oil delivered to the engine has little effect on coking.

It is generally specified that oil shall not enter an aircraft engine at a temperature higher than 70°C., and as far as possible efforts are made to ensure that outlet temperatures do not exceed 100°C., this is why oil coolers are fitted.

The reasons for this are many; first, the viscosity of oils at the higher temperatures is getting low and is likely to lead to trouble with heavily loaded bearings; secondly, the oil consumption goes up rapidly with the higher temperatures; thirdly, there is a difficulty in maintaining reasonable oil pressures at such excessive temperatures; and last, but not least, the tendency of the oil to oxidise and deteriorate goes up with the working temperature in the engine, to say nothing of the loss of cooling effect on pistons and cylinders and consequent risk of engine.

WILBUR WRIGHT MEMORIAL LECTURE AND CONVERSAZIONE

The Wilbur Wright Memorial Lecture was delivered by the Hon. W. P. MacCracken, Jun., Assistant Secretary of Commerce for Aeronautics and Member of the National Advisory Committee for Aeronautics of the United States of America, in the Science Museum, on July 25th, 1929, before a distinguished audience.

The A nual Council Dinner, preceding the Wilbur Wright Memorial Lecture, was also held, by kind permission of Colonel Sir Henry Lyons, in the Science Museum, South Kensington. The following is a list of the Council and their guests who were present:—

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President), in the chair. Captain P. D. Acland, Professor L. Bairstow, C.B.E., F.R.S., F.R.Ae.S., Major T. M. Barlow, M.Sc. (Eng.), M.Inst.C.E., M.I.Mech.E., F.R.Ae.S., General Bartolucci, Lieut.-Colonel P. E. Bitossi (Italian Air Attaché), Robert Blackburn, Esq., O.B.E., A.M.Inst.C.E., M.I.Mech.E., F.R.Ae.S., M.I.Ae.E., M. L. Bramson, Esq., A.C.G.I., F.R.Ae.S., M.I.Ae.E., Air Vice-Marshal Sir W. Sefton Brancker, K.C.B., A.F.C., Wing Commander T. R. Cave-Browne-Cave, C.B.E., F.R.Ae.S., M. J. B. Davy, Esq., Mons. Charles Dollfus, Mons. de Fleuriau (French Ambassador), Commandant Gailliard (French Military Attaché), Major Lester D. Gardner, A.F.R.Ae.S., Professor Giacomelli, Sir Richard Glazebrook, K.C.B., F.R.S., F.R.Ae.S., J. E. Hodgson, Esq., Lieut. Commander Kingman (American Embassy), Captain A. G. Lamplugh, F.R.Ae.S., M.I.Ae.E., Dr. F. W. Lanchester, Hon. LL.D., F.R.S., Hon. F.R.Ae.S., Herr Langer, Major A. R. Low, M.A., F.R.Ae.S., W. O. Manning, Esq., F.R.Ae.S., Major R. H. Mayo, O.B.E., F.R.Ae.S., Lieut.-Colonel J. T. C. Moore-Brabazon, M.C., F.R.Ae.S., M.I.Ae.E., Colonel Mossbergh (Swedish Air Attaché), F. Handley Page, Esq., C.B.E., F.R.Ae.S., Sir Joseph Petavel, K.B.E., D.Sc., F.R.Ae.S., Captain J. Laurence Pritchard, Hon. F.R.Ae.S., Lieut. de Vaisseau Sala (French Air Attaché), Lieut. Commander W. D. Thomas (American Embassy), H. T. Tizard, Esq., C.B., A.F.C., F.R.S., F.R.Ae.S., Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., C. C. Walker, Esq., F.R.Ae.S., H. E. Wimperis, Esq., C.B.E., F.R.Ae.S., Lawrence A. Wingfield, Esq., M.C., D.F.C., A.R.Ae.S.I., R. McKinnon Wood, Esq., O.B.E., A.M.Inst.C.E., F.R.Ae.S.

Immediately following the dinner and preceding the reading of the Wright Memorial Lecture, the Society celebrated the 20th anniversary of the crossing of the English Channel by M. Blériot by holding a Conversazione in the Science Museum, South Kensington. A very large number of the Society's members and many distinguished guests were present. Members and guests were received by the President (Colonel the Master of Sempill) and the Hon. Mrs. Forbes-Sempill, assisted by the Council. During the evening, by kind permission of the Air Council, the band of H.M. Royal Air Force, conducted by Flight Lieutenant J. H. Amers, M.B.E., Director of Music, R.A.F., played selections.

Among those who were present at the Conversazione and the Lecture were the following :—

Captain P. D. Acland, W. W. Adam, Esq. (Messrs. Ernesto Breda), Patrick Alexander, Esq., G. Allwood, Esq., Major Andrea, Mrs. Andrea, Lt.-Comdr. M. Awaya, I.J.N.

The Hon. Lady Bailey, Professor L. Bairstow, C.B.E., F.R.S., F.R.Ae.S., — Baker, Esq. (Secretary of the British Engineering Standards Association), F. Rodwell Banks, Esq., A.F.R.Ae.S., Major T. M. Barlow, M.Inst.C.E., M.I.Mech.E., F.R.Ae.S., Capt. G. Barnett, A. J. Wallace Barr, Esq., Lt.-Col. J. Barrett-Lennard, C.B.E., General Bartolucci, Mrs. Barton, Ing. A. G. von Baumhauer, Miss M. Beck, Herr Direktor Becker, John Bell, Esq., Mons. D. Bey, Capt. E. N. Bey, Mons. E. Bey, Mons. H. S. Bey, Mons. S. Bey, Mons. T. Bey, Major B. Binyon, A.F.R.Ae.S., Major P. Bishop, O.B.E., A.F.R.Ae.S., Mrs. Bishop, Lieut.-Col. F. Bitossi (Italian Air Attaché), Wing Comdr. H. Blackburn, M.C., A.F.C., R.A.F., A.F.R.Ae.S., Mrs. H. Blackburn, Robert Blackburn, Esq., O.B.E., M.I.Ae.E., F.R.Ae.S., Mrs. Robert Blackburn, Dr. Bohm, Dr. Paolo Bompard, M. Bonton, Esq., Mrs. Bonton, C. R. Borkland, Esq., Lt.-Comdr. S. Boudouris, H. D. Boultbee, Esq., A.F.R.Ae.S., Mrs. Boultbee, M. L. Bramson, Esq., F.R.Ae.S., M.I.Ae.E., Mrs. Bramson, Air Vice-Marshal Sir W. Sefton Brancker, K.C.B., A.F.C., L. Brawne-Lindon, Esq., M. Louis Breguet, M. Breguet, Jun., Comdr. E. F. Briggs, D.S.O., O.B.E., Mrs. Briggs, — Broadbent, Esq., Flt. Lieut. G. M. Bryer, A.F.R.Ae.S., Major G. P. Bulman, O.B.E., A.F.R.Ae.S., Mrs. Bulman, Squadron Leader C. G. Burge, O.B.E., A.R.Ae.S.I., Mnr. Burgerhault, Capt. Stewart Burt, Colonel Butcher, D.S.O., Mrs. Butcher.

Mnr. Cabos, Miss J. Campbell, A. N. Caple, Esq., R. S. Capon, Esq., F.R.Ae.S., Mrs. Capon, Miss C. Capps, Snr. Caproni, Major B. C. Carter, F.R.Ae.S., Mrs. Carter, Wing Comdr. T. R. Cave-Browne-Cave, C.B.E., A.M.I.Mech.E., A.M.I.N.A., F.R.Ae.S., Mrs. Cave-Browne-Cave, Capt. J. F. Chambers (Inspection Dept., Woolwich), Air Commodore J. A. Chamier, C.B., C.M.G., D.S.O., O.B.E., Mrs. Chamier, Miss L. M. A. Chitty, A.F.R.Ae.S., A. E. L. Chorlton, Esq., C.B.E., M.Inst.C.E., M.I.Mech.E., F.R.Ae.S., Group Capt. M. G. Christie, E. J. Clark, Esq., A.R.Ae.S.I., Mrs. Clark, F. S. Clark, Esq., Major Cleghorn, Mrs. Cleghorn, C. V. Coates, Esq., M.A., A.F.R.Ae.S., Miss T. Coates, Sir Alan J. Cobham, K.B.E., A.F.C., Lady Cobham, Miss E. Collins, C. H. Colson, Esq., C.B.E., M.Inst.C.E., Lieut. Comdr. C. N. Colson, A.R.Ae.S.I., W. L. Cooper, Esq. (American Commercial Attaché), Mrs. Cooper, J. W. Copley, Esq., the Hon. Mr. Justice Costello, Colonel Crompton (President of the British Engineering Standards Association), L. Cullis, Esq., A.F.R.Ae.S., Mrs. Cullis, Miss D. M. Cumming.

G. L. O. Davidson, Esq., M. J. B. Davy, Esq., Mrs. Davy, F. G. T. Dawson, Esq., Brig.-General Sir C. Delmé-Radcliffe, K.C.M.G., C.V.O., Dr. Davis R. Dewey, Mrs. Dewey, Lieut. Cmdr. J. Dimakis, S. A. Dismore, Esq., Mrs. Dismore, Mons. Charles Dollfus.

Squadron Leader T. H. England, D.S.C., A.F.C., A.F.R.Ae.S., Rear-Admiral S. L. Escobar (Chilean Naval Commission), G. E. T. Eyston, Esq.

A. Fage, Esq., F.R.Ae.S., Mrs. Fage, C. R. Fairey, Esq., M.B.E., F.R.Ae.S., Lieut. Comdr. G. Falconakis, W. S. Farren, Esq., F.R.Ae.S., M.I.Ae.E., Lieut.-Col. L. F. R. Fell, D.S.O., O.B.E., F.R.Ae.S., Captain Ferruh (Turkish Embassy), Colonel Fierz, Mons. Fleuriot (the French Ambassador), R. E. Fordham, Esq., Mrs. Fordham, Miss Fordham, Mons. P. Franck, Snr. Isotta Fraschini, Dr. Wm. G. Friedrich, M.E., M.S.A.E., Comp. R.Ae.S.I., Mrs. Friedrich, Mrs. Fullerton.

Commandant Gailliard (French Military Attaché), Major Lester D. Gardner, A.F.R.Ae.S., Mrs. Lester Gardner, — Gell, Esq., D. W. Genge, Esq., C. W. George, Esq., Mrs. George, Mons. P. Gheorghiu, Professor Giacomelli, R. D. Given, Esq., H. Glaser, Esq., O.B.E., A.F.R.Ae.S., H. Glauert, Esq., F.R.Ae.S., Mrs. Glauert, Sir Richard Glazebrook, K.C.B., F.R.S., F.R.Ae.S., Major F. M. Green, F.R.Ae.S , Mrs. Green, Miss Green, H. S. Green, Esq., M.I.Ae.E., Mrs. Greenall, C. G. Grey, Esq., Mrs. Grey, W. H. Grieve, Esq., Mrs. Grieve, P. T. Griffith, Esq., A.F.R.Ae.S., Mrs. Griffith, J. E. Griffiths, Esq., — Grosfils, Esq., Mrs. Grosfils.

Squadron Leader R. A. de H. Haig, A.F.C., A.F.R.Ae.S., Mrs. Haig, A. H. Hall, Esq , C.B.E., A.F.R.Ae.S., Mrs. Hall, S. Scott Hall, Esq., M.Sc., D.I.C., Mrs. Scott Hall, M. Hanstock, Esq., Herr Hantelmann, C. W. Hayward, Esq., A. G. Hazell, Esq., A. C. Healey, Esq., F. J. Healey, Esq., Mrs. F. J. Healey, The Naval Attaché (Hellenic Legation), Major H. Hemming, A.F.C., A.F.R.Ae.S., F.R.G.S., Mrs. Hemming, R. C. B. Hendy, Esq., A.M.I.Ae.E., E. T. Hicks, Esq., — Hill, Esq., Mrs. Hill, Capt. G. T. R. Hill, F.R.Ae.S., J. E. Hodgson, Esq., J. L. Hodgson, Esq., A.F.R.Ae.S., Capt. Hoegger, M. Shadwell Hooper, Esq., A.F.R.Ae.S., Mrs. Shadwell Hooper, Miss Hounsell, H. B. Howard, Esq., A.F.R.Ae.S., Mrs. Howard, L. Howard-Flanders, Esq., A.F.R.Ae.S., A.M.I.Mech.E., M.I.Ae.E., Wing Comdr. G. B. Hynes, D.S.O., R.A.F., Mrs. Hynes.

T. Illingworth, Esq., H. B. Irving, Esq., B.Sc., A.F.R.Ae.S., Captain J. S. Irving, M.I.Mech.E., A.F.R.Ae.S., Mrs. Irving, Miss Irving.

Miss G. Jacobs, Miss F. Jarvis, J. Jarvis, Esq., Mrs. Jarvis, — Jennings, Esq., Mrs. Jennings, Professor B. Melvill-Jones, A.F.C., M.A., F.R.Ae.S., F. H. Jones, Esq., Miss N. G. Jones.

Herr Karlowa, R. C. Kemp, Esq., M. H. Kennedy, Esq., J. S. Kewley, Esq., A.F.R.Ae.S., Mrs. Kewley, Lieut. J. Kiaziu, Lieut.-Comdr. Kingman (American Naval Attaché), T. A. Kirkup, Esq., A.F.R.Ae.S., W. S. Knott, Esq., Comdr. Kondo, Squadron Leader A. Kubita (Czechoslovakian Air and Military Attaché).

Lieut.-Col. Laing, Capt. A. G. Lamplugh, F.R.Ae.S., M.I.Ae.E., Dr. F. W. Lanchester, Hon. LL.D., F.R.S., Hon. F.R.Ae.S., Herr Langer, M. Langley, Esq., A.M.I.Ae.E., Cav. E. Lanzerotti Spina, A.F.R.Ae.S., Mrs. Lanzerotti Spina, The Military Attaché (Latvian Legation), Mrs. Le Blond, Major Sir Humphrey Leggett, D.S.O., Lady Leggett, Frank Lord, Esq., John Lord, Esq., F.R.Ae.S., Major A. R. Low, F.R.Ae.S.

Captain J. C. MacArthur (Assistant Military Attaché, American Embassy), Sir Francis McClean, A.F.C., A.F.R.Ae.S., Lady McClean, the Hon. Wm. P. MacCracken, Jun. (Assistant Secretary of Commerce for Aeronautics of the U.S.A.), Miss McCormick, Lieut.-Col. M. N. MacLeod, D.S.O., M.C., R.E., Prof. Dr. Ing. G. Madelung, Col. the Marquis Malda, L. Manning, Esq., W. O. Manning, Esq., F.R.Ae.S., H. Marns, Esq., Comdr. Masuda, I.J.N., Col. J. S. Matthew, C.M.G., D.S.O., R. Borlase Matthews, Esq., F.R.Ae.S., Mrs. Borlase Matthews, Major R. H. Mayo, O.B.E., F.R.Ae.S., H. A. Mettam, Esq., Major T. B. Meyer, G. B. Miller, Esq., Dr. F. G. Merton, M.C., M.A., Mrs. Merton, Wing Comdr. W. Millet, — Mills, Esq., the Hon. Ewen Montagu, Lieut-Col. J. T. C. Moore-Brabazon, M.C., F.R.Ae.S., M.I.Ae.E., Colonel Mossberg (Swedish Air Attaché), S. R. Mullard, Esq., A.F.R.Ae.S., Mrs. Mullard, Miss Mullard, Lieut.-Col. Muller.

M. Nakimatsu, Esq., J. L. Nayler, Esq., F.R.Ae.S., F./O. C. H. Latimer Needham, F.R.Ae.S., Mrs. Needham, Captain D. Nicolson, A.F.R.Ae.S., — Nevius, Esq., Mrs. Nevius.

Comdr. A. Obrecht, Lieut.-Col. H. W. S. Outram, C.B.E., A.F.R.Ae.S., Mrs. Outram, E. Ower, Esq., A.F.R.Ae.S., Mrs. Ower.

F. Handley Page, Esq., C.B.E., F.R.Ae.S., Mrs. Handley Page, George Parnall, Esq., Miss Parr, Miss W. Penn-Gaskell, Capt. E. W. Percival, A.M.I.Ae.E., R. V. Perfect, Esq., Sir Ernest Petter, Lady Petter, Dip. Ing. Pfisterer, — Picktholl, Esq., Mrs. Picktholl, N. A. V. Piercy, Esq., D.Sc., F.R.Ae.S., Mrs. Piercy, Sub-Lieut. P. Plastiras, Major H. Waymouth Prance, A.F.R.Ae.S., Mrs. Waymouth Prance, Capt. J. Laurence Pritchard, Hon. F.R.Ae.S.

L. G. S. Reynolds, Esq., Mrs. Reynolds, Miss D. Richardson, Lieut.-Col. V. C. Richmond, O.B.E., F.R.Ae.S., Mrs. Richmond, T. B. Ringwood, Esq., A.M.I.Ae.E., Mrs. Ringwood Capt. E. Rivera, Gilmour Robinson, Esq., Miss E. M. Robinson, G. K. Rose, Esq., Mrs. Rose.

Miss O. St. B. St. Barbe, Lieut. de Vaisseau Sala (French Air Attaché), Mons. A. Saurer, W. P. Savage, Esq., A.F.R.Ae.S., Mrs. Savage, The Director (Messrs. Schmidt, B.F.W.), Major Sefik (Turkish Embassy), Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President, Royal Aeronautical Society), the Hon. Mrs. Forbes-Sempill, Comdr. Prince Shimadzu, I.J.N., Mnr. Slot, Mons. A. M. H. Solomon, R. V. Southwell, Esq., F.R.Ae.S., Wing Comdr. J. Sowrey, A.F.C., R.A.F., M.I.Ae.E., Mrs. Sowrey, The Secretary of the Spanish Royal Naval Commission, Dr. R. Steele, G. A. Temple Stenning, Esq., W. S. Stephenson, Esq., M. Stern, Esq., Colonel Sternverg, H. J. Stieger, Esq., D.I.C., A.F.R.Ae.S., Mrs. Stieger, Mrs. H. Stuart, E. S. Stubbs, Esq., Miss Sturrock, J. Suthering, Esq., A.R.Ae.S.I., H. C. Sutton, Esq., M.Sc., A.F.R.Ae.S., Mrs. Sutton, Air Vice-Marshal Sir Oliver Swann, K.C.B., C.B.E., Lady Swann, the Dowager Lady Swaythling.

Claude Taylor, Esq., Dr. K. Thalan, Dip. Ing. Thelen, F. A. Thomas, Esq., A.M.I.Ae.E., H. T. Tizard, Esq., C.B., A.F.C., F.R.S., F.R.Ae.S., Capt. Cyril Turner, Mrs. Turner.

Herr Bavrot Hals Uplegger.

Dr. van der Maas, J. Parker van Zandt, Esq., H. T. Vane, Esq., C.B.E., Mons. F. Vesmons (Latvian Legation), Madame Vesmons, Major O. G. G. Villiers, D.S.O., Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., Lady Vyvyan.

C. C. Walker, Esq., F.R.Ae.S., Mrs. Walker, Capt. F. R. Walker, Capt. C. E. Ward, Mrs. Ward, Air Commodore A. D. Warrington-Morriss, C.M.G., O.B.E., A.F.R.Ae.S., Mrs. Warrington-Morris, H. G. Watkins, Esq., H. C. Watts, Esq., D.Sc., F.R.Ae.S., Air Commodore J. G. Weir, C.M.G., C.B.E., Mrs. Weir, Lieut.-Col. C. H. Wesson (Assistant American Military Attaché), J. R. Wharton, Esq., Capt. G. S. Wilkinson, F.R.Ae.S., Mrs. F. K. Wilson, H. E. Wimperis, Esq., C.B.E., F.R.Ae.S., Mrs. Wimperis, Miss B. Wimperis, Miss E. Wimperis, Comdr. the Hon. Sir Walter Windham, R.N., Lawrence A. Wingfield, Esq., M.C., D.F.C., A.R.Ae.S.I., Mrs. Wingfield, C. G. H. Winter, Esq., R. McKinnon Wood, Esq., O.B.E., F.R.Ae.S., A. Woollhead, Esq., Mrs. Woollhead, Major Wraith, Squadron Leader M. E. A. Wright, A.F.C., H. B. Wyn-Evans, Esq., A.F.R.Ae.S.

Miss F. Yates, Capt. H. M. Yeatman, M.A. (Cantab), A.F.R.Ae.S., A.M.I.Ae.E.

Mons. D. Zebitch.

Colonel the MASTER OF SEMPILL, A.F.C., A.F.R.Ae.S., President of the Royal Aeronautical Society: Your Excellency, my Lords, Ladies and Gentlemen,—Before I introduce the reader of the Wilbur Wright Memorial Lecture for 1929

it is my pleasant duty to present certain awards which have been made by the Council for the year 1928-29. The first of these is the Sir Charles Wakefield Gold Medal, which has been awarded to Mr. H. B. Irving, of the National Physical Laboratory, for his work on slots and controls. The Sir Charles Wakefield Gold Medal is awarded annually to the designer of any invention or apparatus tending towards safety in flying. The next award of the Council is that of the Simms Gold Medal, awarded annually for the best paper read in any year before the Society on any science allied to aeronautics. The award has been made by the Council to Mr. H. Sutton for his paper on "Corrosion of Light Alloys." The Taylor Gold Medal, awarded annually, at the discretion of the Council, for the most valuable paper submitted or read during the previous session, has been awarded to Professor Melvill-Jones for his very remarkable paper on the "Streamline Aeroplane." The final prize which the Council had awarded was the Edward Busk Memorial Prize, a prize offered annually for the best paper received by the Society on some subject of a technical nature in connection with aeroplanes, including seaplanes. The Council had unanimously awarded the prize this year to Mr. W. S. Farren for his valuable paper on "Monoplanes or Biplanes."

It is now that, with very great pleasure, I introduce to you Mr. MacCracken, who is the reader of the Wilbur Wright Memorial Lecture this evening. As many of you know, the Wilbur Wright Memorial Lecture is the most important lecture of the Society's year. At the reading of the lecture to-night there has gathered together one of the most distinguished audiences which has listened to the lecture. He would like to remind that audience that they had gathered together on hallowed ground. Above their heads were two of the most historic aeroplanes in the world, namely, the original Wright biplane on which the first flight in a power-driven heavier-than-aircraft had been made in December, 1903, and the original Blériot monoplane in which M. Blériot had flown the Channel for the first time that day twenty years ago. Around them, too, were many other historic machines and relics of the efforts which man had made to fly.

Turning to the lecturer, Mr. MacCracken joined the Air Service of the United States Army in 1917, and after receiving his training as a pilot became an instructor in flying. After the armistice he returned to his profession of the law and his ability and high personal qualities were soon recognised by his election as Secretary of the American Bar Association, which comprises all the leading lawyers in the United States.

Mr. MacCracken, through his natural qualities of leadership, took a prominent part in the organisation of aeronautical societies in the United States. He was one of the founders of the National Aeronautical Association and was the Chairman at its first meetings. His advice was sought by some of the largest aeronautical corporations as well as government officials.

When the President's Air Board recommended and Congress authorised the creation of a Bureau of Aeronautics in the Department of Commerce, Mr. MacCracken was the one man with every qualification for the office. He was appointed by Secretary Hoover and became the first official to be charged with the direction and regulation of civil aeronautics in the United States. Some inferences may be drawn as to his success from the fact that the great expansion of commercial aviation in the United States has coincided with Mr. MacCracken's career as Assistant Secretary. Some of the best informed Americans give him the principal credit for the remarkable growth of civil aeronautics in the United States. But it is not only in his official capacity that he has assisted aviation in the last three years. He has, through his great charm of manner and facility of speech made every one air-minded who has heard him. He is a member of

the National Advisory Committee for Aeronautics and has just come from Paris where he represented the United States at the meeting to consider a reunion of the International Air Convention.

The President then read the following telegrams which had been sent and received:—

To M. Blériot.

The Members of the Royal Aeronautical Society assembled with their guests in the Science Museum to hear the delivery of the 17th Wilbur Wright Memorial Lecture by a distinguished American are mindful of your epoch-making flight of twenty years ago. We appreciate your own country's prior right to your presence on this day and pay homage to you in spirit through the medium of your historic machine, which we are proud to have in our care on this memorable occasion.

SEMPILL, *President.*

From Blériot.

I am deeply touched by the cordial message received from the Royal Aeronautical Society, the oldest aeronautical institution in the world, which with its guests will be gathered together in the shadow of the wings of my twenty-year-old-machine, and regret that even the speed of the aeroplane will not allow me to be in Paris and London at the same time. I am looking forward with intense pleasure to attending the closing banquet of your great Exhibition on Saturday.

From M. Painleve, Minister of War for France.

One of Wilbur Wright's first passengers regrets being unable to be present to-night, and sends an expression of his admiration of that genial conqueror of the air, Wilbur Wright.

PAUL PAINLEVE.

To Orville Wright.

The Royal Aeronautical Society gathered together under the wings of your historic aeroplane (alongside of which is temporarily housed the famous Blériot machine) to hear the 17th Wilbur Wright Memorial Lecture, send you a message of cordial goodwill and appreciation of your great service to aviation and mankind.

SEMPILL, *President.*

From Orville Wright.

Please accept my hearty greetings on the reading of Wilbur Wright Lecture by our friend MacCracken on the anniversary of Blériot's memorable flight and also an expression of my appreciation of the great value of the Society's work during the past year.

ORVILLE WRIGHT.

The Hon. William P. MacCracken then delivered his lecture:—

SCIENCE IN RELATION TO REGULATING AND PROMOTING CIVIL AVIATION

During the past quarter of a century great strides have been made in perfecting the science of aviation. Too much credit cannot be given to the men who have laboured untiringly in the laboratories in an endeavour to determine with mathematical certainty the physical laws that govern the mechanical devices which mankind is using in his conquest of the air.

Science has done more for civil aviation, however, than unravel the mysteries of aerodynamics and internal combustion engines. It has provided many important aids to air navigation, such as improved lighting facilities for airways and airports, wireless as a means of communication between ground and aeroplane, and also as a beacon to guide the pilot on his course, and numerous instruments which now adorn the cockpit of every aeroplane.

While at times the development of air transport may suffer because of lack of co-ordination between the laboratory and the factory, it will suffer far more should a similar condition exist between the scientists and those charged with the duty of regulating and promoting civil aviation.

In order to achieve success in the application of aviation to civilian activities, both commercial and non-commercial, it is necessary to have the closest possible co-operation between these two important agencies. Their problems and methods of dealing with them must of necessity be quite different, though their mutual aim is to increase the scope of air transport service.

It would seem that there are five fundamental factors which are controlling in the development of any form of transportation. These are: Safety, speed, reliability, cost and comfort. While opinion may differ as to the relative importance of these factors it is not essential that this question be solved. They are far from being separate and apart from each other. In fact, they are so interwoven that it is impossible to deal with one without in some degree affecting the others. They are not mentioned as a list of sub-headings but rather that they may be borne in mind throughout this paper. They are the weather vanes that indicate to scientists, manufacturers, financiers, operators, insurers, Government officials and the general public alike, the progress which civil aviation is making. Each of these groups may either, by their action or inaction, materially affect the development of civil aviation.

In presenting one's views on such a subject as this, it seems advisable to draw primarily on one's own experience. Therefore, you will pardon me if I approach the subject from the point of view of what has taken place in the United States during the past few years. Also may I direct your attention at the outset to the fact that I am not an engineer nor a graduate of a technical school. This will no doubt be obvious before long, but there is no reason for concealing it even in the beginning.

The Air Commerce Act, which constitutes the legal basis for the promotion and regulation of aviation in the United States, was approved May 20th, 1926. It vested in the Secretary of Commerce power by regulation to provide for the licensing of aircraft and airmen, the establishment of air traffic rules and the rating of airports. Only aircraft and airmen engaged in inter-State and foreign commerce, as defined by the Act, were required to secure these licences, but others were at liberty to apply for them if they chose to do so. The air traffic rules, however, were made applicable to all those engaged in flying in the United States and its territorial possessions, except aircraft belonging to the national

defence forces when operating over their own aerodromes or upon tactical missions.

The Act also charged the Secretary with the duty of fostering and promoting air commerce, specifying particularly the establishment of civil airways, the erection and maintenance of aids to air navigation other than airports and the exchange with foreign Governments, through existing Governmental channels, of information pertaining to civil air navigation as part of these duties.

When this Act was passed there were five distinct groups of scientists dealing with aeronautical problems. There was one group in the industry, another in educational institutions, a third composed of the technicians in the national defence forces, a fourth in the Government service known as the Bureau of Standards which is an integral part of the Department of Commerce, and the fifth likewise in the Government service, but under the jurisdiction and control of a committee composed of representatives from the other four groups and known as the National Advisory Committee for Aeronautics.

Under such circumstances, it is obvious that there was no occasion to create another purely scientific agency to assist in carrying out the provisions of the law. In fact one of the controlling reasons for assigning these new functions to the Department of Commerce was that there were already in that department at least four bureaus which could logically be expected to assist in carrying out the duties prescribed by the Act. These were the Lighthouse Bureau, to which was assigned air navigation facilities; the Bureau of Standards, to which was assigned research problems, engine testing and similar duties; the Coast and Geodetic Survey, which now makes our aeronautical maps; and the Bureau of Foreign and Domestic Commerce, which is promoting foreign trade in aircraft. Two new divisions have been created, one known as the Air Regulations Division and the other as the Airports and Aeronautic Information Division. The aeronautical divisions of these four older bureaus and the two new divisions constitute what is known as the Aeronautics Branch of the department.

The two most important problems at the outset were the promulgation of regulations and the establishment of aids to air navigation.

Over six months were spent in the preparation of the regulations. During this period the experience of other nations in dealing with this subject was carefully studied.

A preliminary draft of the regulations was prepared and submitted for criticisms to representatives of the aviation personnel of the Army, Navy, Post Office Department and the National Advisory Committee for Aeronautics. The draft was revised in the light of these criticisms and was then submitted to the manufacturers, operators, insurance underwriters and other similar groups interested in aviation. They were invited to submit written criticisms and also to attend group meetings held under the auspices of the department. All sections of the proposed regulations were submitted for discussion at each of the group meetings. At the conclusion of these meetings the draft was revised and circulated to all those who attended any of the group conferences or had submitted written criticisms, with the request that if they had any further comments to make they submit them in writing. Then followed the final revision and the original regulations became effective December 31st, 1926. At each of the group conferences there were one or more men who could be classified primarily as scientists, and underlying all the discussions were the same five fundamental factors of safety, speed, reliability, cost and comfort. Each year since the regulations were promulgated, the department has had an annual conference open to all interested in aviation. These have been very well attended by representatives of all the various groups having occasion to deal with the department on aeronautical matters. While the principal subject of discussion has been proposed amendments to the Air Commerce Regulations, an opportunity has been afforded to discuss every phase of the department's aeronautical activities. Many

special conferences have also been held dealing with such subjects as materials for landing strips, fire prevention in hangars, and the like. It is important not only that there should be the closest co-operation between scientists and the regulatory authorities, but also between the industry and Government officials.

To one of royal station rather than of scientific trend of mind is attributed the saying that "the test of the pudding is in the eating." While it would be arrogant indeed to attribute to the regulations themselves, the manner of their enforcement, or to the combined activities of the department the progress which has so recently been achieved in civil aviation in the United States, nevertheless, they have had sufficient bearing upon that progress to warrant referring to them in connection with what has transpired. Before doing so, however, it might be well to point out that wherever possible pilots have been employed to do aviation work in the department. This applies to office as well as field positions. Naturally all the inspectors are pilots, as are the airway extension superintendents. Even the clerical and stenographic personnel have been afforded opportunities to fly if they cared to do so. We want them to be not only air-minded, but air-wise.

There had been some activity in civil aviation during the year 1926, in reliance upon the promise of the administration and the responsible leaders in Congress, that a definite federal aviation policy, as later set forth in the Air Commerce Act, would be adopted. Therefore, in order to properly present the picture, it is fair to make a comparison beginning with the 1st of January, 1926. At that time almost all the aircraft in civilian hands consisted of war surplus training planes which had been adapted to various civilian uses. There were a few manufacturers of civil aircraft who were building a limited quantity of new models, largely along the lines of military training planes, and in almost every instance without the aid of any real scientific engineering staff. These planes were for the most part powered with war surplus engines and their use was confined to carrying passengers on short flights, instructing a few students, a limited amount of aerial photography, crop dusting, and aerial taxying.

The only scheduled flying was done by the Post Office Department, which had established an airway from New York to San Francisco, a distance of less than 3,000 miles. This airway was lighted from New York to Salt Lake City, a distance of 2,000 miles. There was a single daily schedule in each direction over the entire route, and a day and night schedule between New York and Chicago. The public as a whole took very little interest in the air mail service, and still less in the other forms of civilian aviation.

In the accompanying chart (No. 1) there is a map of the United States

FIG 1.

showing the New York—Chicago—San Francisco route; superimposed on this map is a dotted map of Europe upon the same scale. You will note that on the European map the cities of London and Chicago are at the same point, and that New York is on the eastern border of Germany, with Warsaw a relatively short distance away.

FIG. 2.

Chart No. 2 is a map of the United States showing the airways in operation at the present time. These two charts show at a glance the progress that has been made in scheduled flying throughout the United States during this $3\frac{1}{2}$-year period. Connections have also been established with lines to Mexico City, and routes are in operation between the United States and Porto Rico and the United States and South and Central America via Cuba.

The advantage of the vast distances in the United States to aeronautical development is quite apparent from chart No. 1, but experience has shown that the longest routes are not uniformly the most profitable. The determining factor involves, among other items, the available traffic and cost on the one hand and the speed and reliability of the service on the other.

Naturally with such a rapid development in air transport one would expect a corresponding increase in the aircraft industry and other aeronautical services. However, the increment in this field has been even greater than in air transport. This is graphically depicted in chart No. 3. While all aeroplane manufacturers are included in the total, it should be mentioned that some of them are quite limited as to production and capitalisation. The attitude of the public towards aviation may be gauged by the increase in the number of miles flown in each year and the number of passengers carried. Figures for the first six months of 1929 were not available in time to be included on this chart, but more passengers were carried during that half year than during all of 1928, and the daily average mileage for scheduled operations during the first six months of 1929 was three times what it was for the same period in 1928.

In presenting chart No. 3A, attention should be called to the fact that 75 per cent. of commercial aeroplane manufactures in 1928 were of the open cockpit type, suitable for accommodating from one to three persons. This equipment is used primarily for civilian training and sport flying. You will also note on this chart the number of approved types certificates issued by the department. It is not a very impressive looking part of this chart, but after all it tells a very

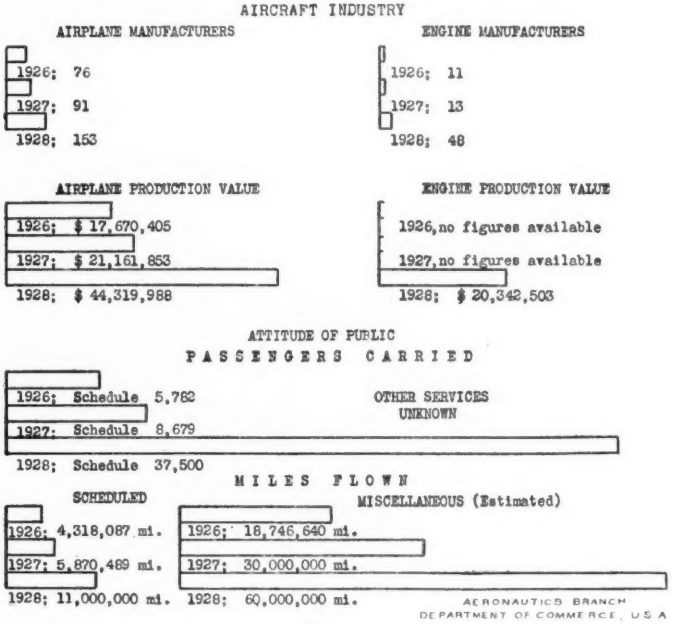

AIRCRAFT INDUSTRY
AIRPLANE MANUFACTURERS
1926; 76
1927; 91
1928; 153
ENGINE MANUFACTURERS
1926; 11
1927; 13
1928; 48
AIRPLANE PRODUCTION VALUE
1926; $ 17,670,405
1927; $ 21,161,853
1928; $ 44,319,988
ENGINE PRODUCTION VALUE
1926, no figures available
1927, no figures available
1928; $ 20,342,503
ATTITUDE OF PUBLIC
PASSENGERS CARRIED
1926; Schedule 5,782
1927; Schedule 8,679
1928; Schedule 37,500
OTHER SERVICES UNKNOWN
MILES FLOWN
SCHEDULED
1926; 4,318,087 mi.
1927; 5,870,489 mi.
1928; 11,000,000 mi.
MISCELLANEOUS (Estimated)
1926; 18,746,640 mi.
1927; 30,000,000 mi.
1928; 60,000,000 mi.
AERONAUTICS BRANCH
DEPARTMENT OF COMMERCE, U.S.A.

FIG. 3.

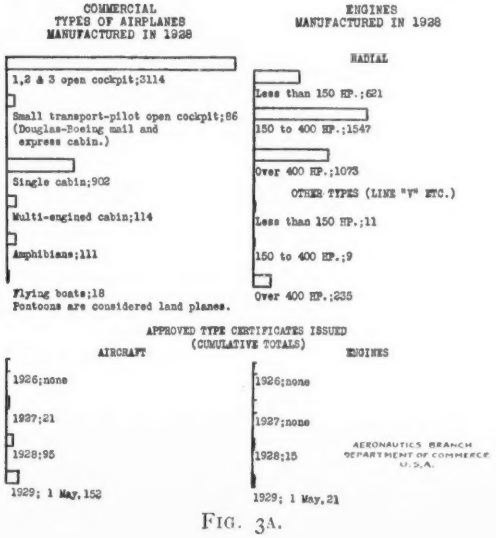

COMMERCIAL
TYPES OF AIRPLANES
MANUFACTURED IN 1928
1,2 & 3 open cockpit;3114
Small transport-pilot open cockpit;86
(Douglas-Boeing mail and express cabin.)
Single cabin;902
Multi-engined cabin;114
Amphibians;111
Flying boats;18
Pontoons are considered land planes.
ENGINES
MANUFACTURED IN 1928
RADIAL
Less than 150 HP.;621
150 to 400 HP.;1547
Over 400 HP.;1073
OTHER TYPES (LINE "V" ETC.)
Less than 150 HP.;11
150 to 400 HP.;9
Over 400 HP.;235
APPROVED TYPE CERTIFICATES ISSUED
(CUMULATIVE TOTALS)
AIRCRAFT
1926;none
1927;21
1928;95
1929; 1 May,152
ENGINES
1926;none
1927;none
1928;15
1929; 1 May,21
AERONAUTICS BRANCH
DEPARTMENT OF COMMERCE
U.S.A.

FIG. 3A.

important story. By way of explanation, may I describe what is involved in securing an approved type certificate for aircraft. Manufacturers must first submit to the Air Regulations Division complete plans, specifications and drawings of the aircraft, together with a stress analysis certified by a competent aeronautical engineer. These data are checked by aeronautical engineers in the employ of the Engineering Section. In cases where they do not conform to the safety factors and practices prescribed by our airworthiness requirements, the question is taken up with the engineers for the manufacturer.

Static tests are not required in every instance but will always be accepted, and may be required when the department's and manufacturer's engineers are in disagreement as to the strength of the structure. When these discrepancies, if any, are all satisfactorily adjusted, the application is then referred to the Inspection Section. This section first sends one of its men to the factory to check up the materials they are using and their shop practices. When specifications, materials and factory are approved, and a plane is built in accordance therewith, it is given what is termed an engineering flight test by one of the department's engineering inspectors. When this test is passed, the certificate is issued. The manufacturer is then entitled to build planes similar to the one which passed the final engineering flight test with the assurance that they will be licensed, provided the planes, including workmanship and materials, conform with the approved specifications. The Government does not keep an inspector continually at the plants, but the plant of a manufacturer holding an approved type certificate is subject to inspection at any time. Frequent factory inspections are made, and if the manufacturer is not complying with the requirements of the department, his certificate may be suspended or revoked.

As regards the manner of testing engines, the department requires that the manufacturer run the preliminary tests at his own factory or at any other place he may select. The final 50-hour test is run by the department at the Bureau of Standards, and constitutes the basis of the h.p. rating and the maximum speed for the propeller setting. In lieu of this test, the department will accept test certificates by either the Army or Navy.

Chart No. 4 is another graphic presentation of the rapid development of aviation during the past three years. It depicts such items as the miles of lighted airways, electric and gas beacons, intermediate or emergency landing fields, wireless communication, and beacon stations and weather service.

The Air Commerce Act prescribes that the Secretary of Commerce shall make recommendations to the Secretary of Agriculture as to the necessary meteorological service for aerial navigation. It has required some study to determine just what type of service was necessary. In making these studies we have had the assistance of the meteorological experts in the Weather Bureau, the Army and Navy, a specialist employed by the Daniel Guggenheim Fund for the Promotion of Aeronautics, as well as the members of our own staff. It would be remiss not to mention the recommendations of the operators and their pilots. All this has resulted in a revised system of aeronautical weather service. The current fiscal year, which began July 1st, 1929, will witness a substantial expansion in this type of service along our airways and particularly in connection with what is known as a secondary network of stations off the airways, but reporting to a central control station on the airway. However, even during this period there has been a marked improvement in the quality of aeronautical weather service with a corresponding reduction in the percentage of accidents due to adverse weather conditions, as will appear later in chart 13. The Department of Commerce furnishes communication facilities for disseminating weather information once it is prepared by the meteorological authorities. For distributing this information wireless, teletype, telephone and telegraph are used.

The teletype has been found particularly useful not only in connection with transmitting weather information, but also other information pertaining to air operations. It consists of a series of typewriters installed at the various airports along a particular route. A message written by an operator at one machine is automatically recorded on a tape by every other machine attached to the circuit. Circuits may be joined together or disconnected by means of a switch board as occasion requires. The fact that the wireless bands available for aeronautical communications are limited in number requires that they be conserved as far as possible for communicating with aircraft in flight. This makes it necessary to use every practicable means of ground communication for transmitting information from one airport or intermediate landing field to another.

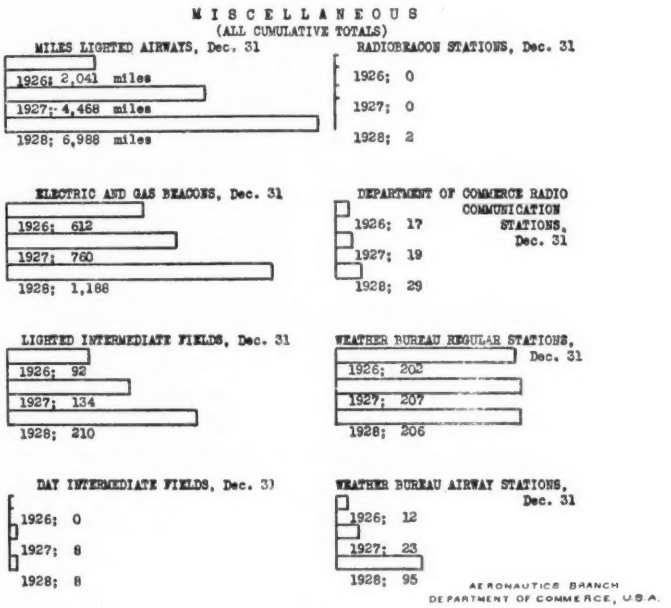


FIG. 4.

While the chart shows that during 1928 only two wireless beacon stations had been installed, these demonstrated conclusively the practicability of this particular type of air navigation facility, and the programme for the current year contemplates a substantial extension of this service.

The wireless beacon consists of a mechanically operated station transmitting two or more signals over antennæ set at fixed angles to each other. The mechanical transmitters are so synchronised that three signals are sent out by each pair of transmitters, one on the right of a given course, the other on the left of the given course and by overlapping a dot with a dash a third signal is sent out on the course itself. In the preliminary stages it was necessary for the pilots or navigators to wear a headphone and to listen constantly for the signals. However, there has now been developed by the aid of scientific research a visual indicator of the vibrating reed type which can be installed in the pilot's cockpit and which automatically informs the pilot whether he is on the given course or to the left or right of it.

Another index of the rapid increase in air operation will be found upon examination of chart No. 5. This depicts the number of licences of various kinds which have been applied for and issued. It will be noted that there has been a decrease in the number of temporary licences. These were made necessary by the fact that during the years 1927 and 1928 the applications were received much faster than they could be handled, with the result that it was found expedient to issue temporary licences in order to avoid seriously interfering with commercial aerial operations.

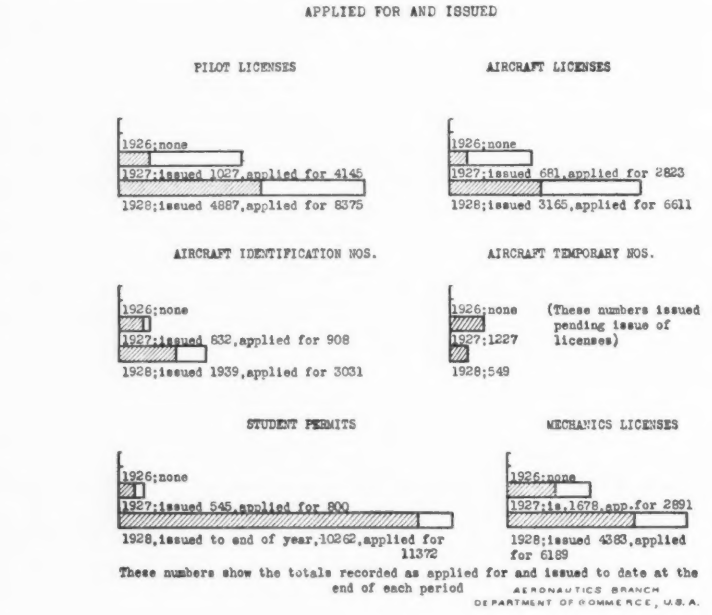


FIG. 5.

The air commerce regulations provide for four classes of pilots' licences in addition to student pilots' permits. However, the fact that a comparatively small number of industrial pilot licences have been issued indicates that there is no further need for continuing this particular classification. An analysis of these various classifications appears in chart 6.

It is particularly noteworthy that the number of transport pilots almost quadrupled between the years 1927 and 1928. It exceeds by 100 per cent. the expansion of the airway mileage during the same period and yet there was a shortage of transport pilots. The most impressive fact, however, shown by this chart is the large number of student pilot permits issued during the year 1928. At the present time there is every indication that a substantial increase will be made during the current year over the figures of last year.

It might be well to give a short explanation with reference to student pilots' permits. These are required only when a student is taking instruction in licensed equipment. In order to secure a student pilot's permit, the applicant must go to a physician designated as an authorised examiner by the Department of Commerce. The student may elect to take the physical examination prescribed for either a private, an industrial, a limited commercial, or a transport pilot's

licence. The examiner's fees, which range from $10 to $15 according to the type of examination, are paid by the student. In making application he or she must indicate the school in which enrolled. These permits are valid for one year from the date of issue, but may be renewed at the expiration of that period by passing another physical examination.

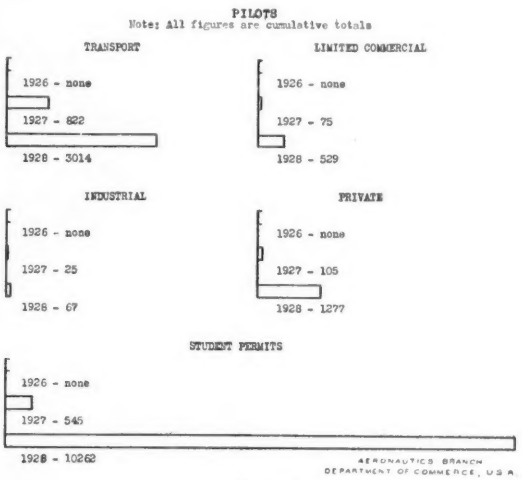


FIG. 6.

Chart 7 shows a steady growth in the total number of applications for pilots', students', mechanics' and aircraft licences during the period from July 1st, 1927, to February 28th, 1929. The expansion of the airway system from

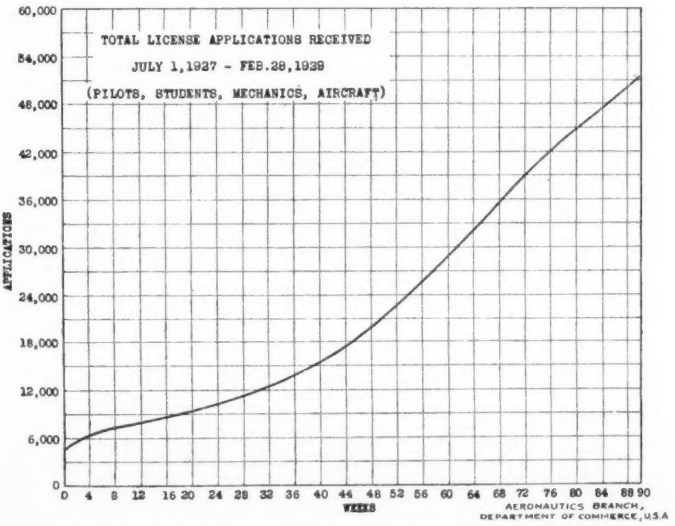


FIG. 7.

8,404 miles in 1926 to 16,667 miles in 1928 is portrayed in chart No. 8. This, in conjunction with the map on chart 8A, shows what has been accomplished in developing the airway system of the United States with the exception of the combined air and rail service between the Atlantic and the Pacific coasts. At the present time the total lighted airways exceeds 10,000 miles in length and the programme for the new fiscal year, when carried into effect, will provide approximately 4,000 additional miles of lighted airways. During this three-year period there has been a very substantial improvement in the lighting equipment. Originally it consisted of one revolving beacon of two-million candle power

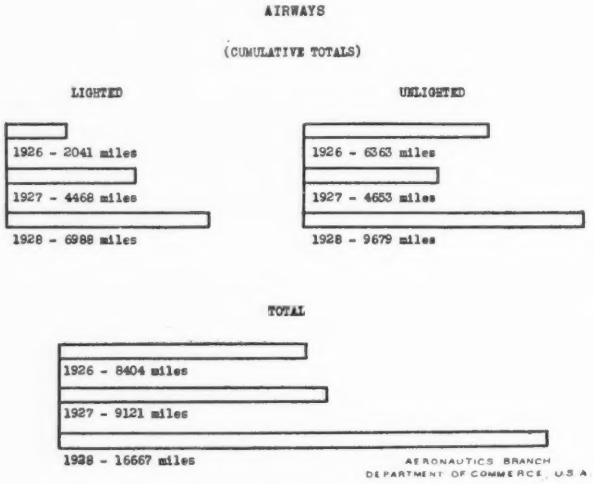


FIG. 8.

every 25 miles with intermediate acetylene flashing beacons at from three to five miles' intervals. The standard equipment to-day consists of one revolving 2,000,000 candle power beacon every 10 miles. A lens has been inserted in the top of the beacon permitting the stray light to shine upward to serve as a ceiling light; in addition to this, the revolving light has on each side of it two stationary lights of 500,000 candle power which shine in opposite directions up and down the course. These lights flash the number of the beacon in the Morse code when the revolving light is shining off the course.

The lens of the course lights is red for beacons which are not placed at intermediate landing fields and is amber coloured if the beacon is located at an intermediate landing field. A green lens is used at the airports. The lens of the revolving beacons along the airway is white. At the base of each beacon is a large concrete arrow pointing along the course. It is flood lighted at night and has painted on it letters identifying the course and numerals indicating the number of the particular beacon. This is really a very matter-of-fact description of the accomplishments of those illuminating engineers who have wrestled with this problem. They have also made marked progress in illuminating airports for night operations and equipping the planes themselves with improved landing lights.

In addition to lighting and marking the airways, the Federal Government, with the aid of various civic organisations, has undertaken a campaign to prevail upon municipalities, railroads and corporations to provide airway marking

insignias on the roofs of buildings or in public squares in order to inform the pilot of his location, compass direction and the direction and distance to the nearest airport. In order that this work might be done with uniformity to the best possible advantage, a research programme was organised. It was carried out over a considerable period of time and involved the selection of contrasting colours, size and shape of letters, as well as experiments in illumination for night operations.

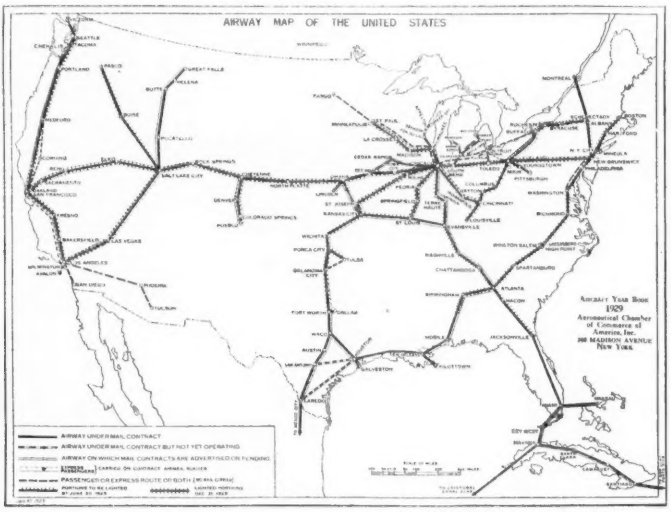

AIRWAY MAP OF THE UNITED STATES
AIRWAY UNDER MAIL CONTRACT
AIRWAY UNDER MAIL CONTRACT BUT NOT YET OPERATING
AIRWAY ON WHICH MAIL CONTRACTS ARE ADVERTISED OR PENDING
CARRIED ON CONTRACT AIRMAIL ROUTES
PASSENGER OR EXPRESS ROUTE OR BOTH (NO MAIL CARRIED)
PORTIONS TO BE LIGHTED BY JUNE 30, 1929
LIGHTED PORTIONS DEC. 31, 1928
AIRCRAFT YEAR BOOK 1929
Aeronautical Chamber of Commerce of America, Inc.
366 MADISON AVENUE NEW YORK

FIG. 8A.

As air mail constitutes the backbone of scheduled airway operations, it is important to show the increase in air mail poundage and mileage during the period under consideration. This appears in chart No. 9. In explanation of

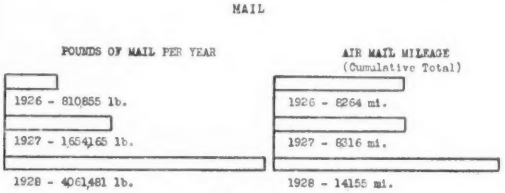
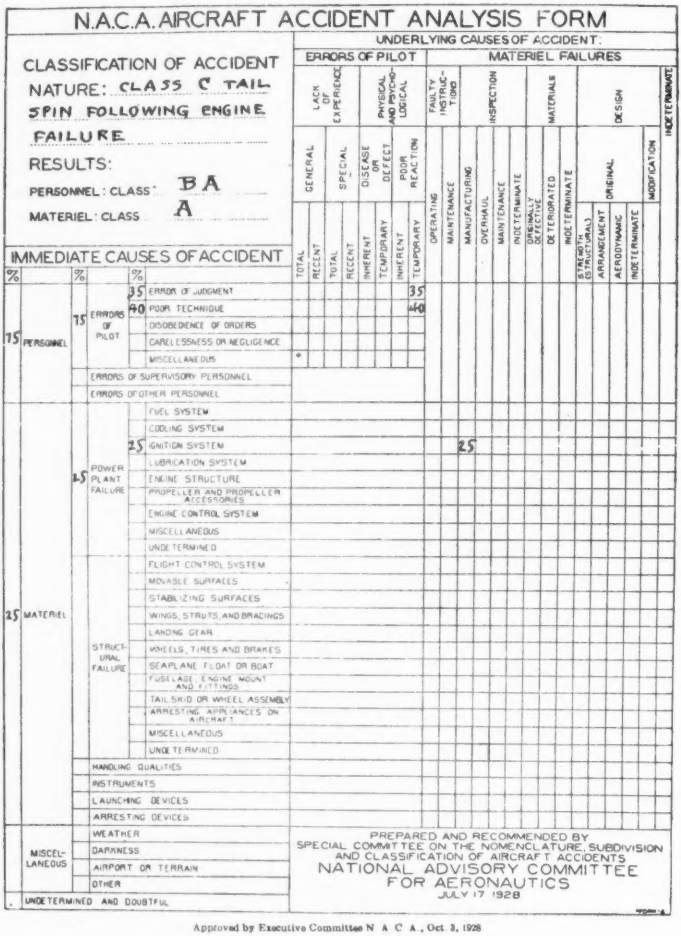


FIG. 9.

this increase it should be pointed out that not only have more communities been accorded the benefit of air mail service by the new mileage and its speed and reliability increased, but also that on August 1st, 1928, the air mail rates were substantially reduced. The theory of our contract mail law is that the excess revenue derived from the sale of air mail postage should be paid to the contractors as compensation for the services rendered. However, under the system of awarding contracts by competitive bidding, the rates charged to the Post Office Department were substantially reduced during the latter part of 1927 and the early part of 1928. As it was never contemplated that the Post Office should profit from its air mail service, the law was amended authorising a reduction

in the rates charged to aerial postal users. While it is true that this reduction was of such a substantial nature as to result in a loss to the Post Office Department, the law empowered the Postmaster-General to negotiate for a six-year extension of existing contracts on the basis of a downward revision of the rate



N.A.C.A. AIRCRAFT ACCIDENT ANALYSIS FORM

CLASSIFICATION OF ACCIDENT
NATURE: CLASS C TAIL SPIN FOLLOWING ENGINE FAILURE
RESULTS:
PERSONNEL: CLASS B A
MATERIEL: CLASS A

UNDERLYING CAUSES OF ACCIDENT:

ERRORS OF PILOT: LACK OF EXPERIENCE — GENERAL (TOTAL, RECENT); SPECIAL (TOTAL, RECENT); PHYSICAL AND PSYCHOLOGICAL — DISEASE OR DEFECT (INHERENT, TEMPORARY); POOR REACTION (INHERENT, TEMPORARY)

MATERIEL FAILURES: FAULTY INSTRUCTIONS (OPERATING, MAINTENANCE, MANUFACTURING); INSPECTION (OVERHAUL, MAINTENANCE, INDETERMINATE); MATERIALS (ORIGINALLY DEFECTIVE, DETERIORATED, INDETERMINATE); DESIGN (STRENGTH (STRUCTURAL), ARRANGEMENT, AERODYNAMIC, INDETERMINATE); MODIFICATION; INDETERMINATE

IMMEDIATE CAUSES OF ACCIDENT

%		%		%		Errors of Pilot: Lack of Experience — General (Total, Recent)	General (Special)	Physical and Psychological — Disease or Defect (Inherent, Temporary)	Poor Reaction (Inherent, Temporary)	Materiel Failures: Faulty Instructions	Inspection	Materials	Design	Modification	Indeterminate
75	PERSONNEL	75	ERRORS OF PILOT	35	ERROR OF JUDGMENT				35						
				40	POOR TECHNIQUE				40						
					DISOBEDIENCE OF ORDERS										
					CARELESSNESS OR NEGLIGENCE										
					MISCELLANEOUS	*									
			ERRORS OF SUPERVISORY PERSONNEL												
			ERRORS OF OTHER PERSONNEL												
25	MATERIEL	25	POWER PLANT FAILURE		FUEL SYSTEM										
					COOLING SYSTEM										
				25	IGNITION SYSTEM					25					
					LUBRICATION SYSTEM										
					ENGINE STRUCTURE										
					PROPELLER AND PROPELLER ACCESSORIES										
					ENGINE CONTROL SYSTEM										
					MISCELLANEOUS										
					UNDETERMINED										
			STRUCTURAL FAILURE		FLIGHT CONTROL SYSTEM										
					MOVABLE SURFACES										
					STABILIZING SURFACES										
					WINGS, STRUTS, AND BRACINGS										
					LANDING GEAR										
					WHEELS, TIRES AND BRAKES										
					SEAPLANE FLOAT OR BOAT										
					FUSELAGE, ENGINE MOUNT AND FITTINGS										
					TAIL SKID OR WHEEL ASSEMBLY										
					ARRESTING APPLIANCES ON AIRCRAFT										
					MISCELLANEOUS										
					UNDETERMINED										
			HANDLING QUALITIES												
			INSTRUMENTS												
			LAUNCHING DEVICES												
			ARRESTING DEVICES												
	MISCELLANEOUS		WEATHER												
			DARKNESS												
			AIRPORT OR TERRAIN												
			OTHER												

* UNDETERMINED AND DOUBTFUL

PREPARED AND RECOMMENDED BY
SPECIAL COMMITTEE ON THE NOMENCLATURE, SUBDIVISION AND CLASSIFICATION OF AIRCRAFT ACCIDENTS
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
JULY 17 1928

Approved by Executive Committee N. A. C. A., Oct. 3, 1928

FIG. 10.

of compensation paid to the contractors. It is believed that the present rate charged can be maintained without involving any greater loss to the Post Office Department than it would sustain if the mails were transported over similar distances by surface carriers. Monthly payments to air mail contractors for the first six months of 1929 were on the basis of more than 500,000 pounds per month.

Perchance it has occurred to you that so far this discussion has touched very casually upon the part that science has played in promoting and regulating civil aviation. However, science has been defined as "knowledge of principles or facts." It therefore seemed appropriate to first give you some of the facts pertaining to the unprecedented expansion in civil aviation which has taken place in the United States.

As was indicated at the outset, one of the most important factors in aeronautical development and regulation involves that of safety. The National Advisory Committee for Aeronautics, in co-operation with the representatives from the Army, Navy and Department of Commerce, organised about a year and half ago, a committee to formulate a uniform method of aircraft accident analysis. All three of these departments had been engaged in accident investigation and analysis, but until this time there had been no attempt at uniformities of terminology or methods which are necessary for a scientific study of the conclusions reached by the investigating authorities. After several months of careful study on the part of the committee, an aircraft accident analysis form was adopted accompanied by a special report containing definitions of the terms used and an explanation of the method of reporting and analysing aircraft accidents. This analysis form appears on chart 10. As copies of the special report have been widely distributed, there is no occasion for going into great details about the report itself. The work of the committee in drafting this analysis form was so thorough and clear that it is possible for any person with a practical knowledge of flying to correctly analyse an accident. The method of analysis recommended was promptly adopted by the Army Air Corps, Bureau of Aeronautics of the Navy and the Aeronautics Branch of the Department of Commerce. Already it has been of great assistance to us in the department in analysing aircraft accidents with a view to modifying the present Air Commerce Regulations in order to make air transport safer.

The result of this analysis for the six months' period, beginning July 1st, 1928, and ending January 1st, 1929, appears in chart 11.

This subject of accident analysis is of sufficient importance to warrant a somewhat detailed description of the manner in which it is conducted.

The Air Commerce Act directs the Secretary "to investigate, record and make public the causes of accidents in civil air navigation in the United States." The Air Commerce Regulations require that "every accident in the operation of licensed aircraft which results in injury to the aircraft shall be reported without delay." They also provide that "when serious injury to personnel or property is suffered or death results a report shall be made by telegraph." When the accident is a minor one, resulting in no serious damage to the plane nor injury to persons, the report of the owner may be submitted to the Accident Board without being investigated by one of the department's inspectors. However, if the plane is seriously damaged or any injury results to pilot or passengers, an inspector of the department is immediately sent to investigate the accident. As was previously pointed out, all the inspectors in the department are men of extensive experience as aeroplane pilots. They secure the statements of all witnesses, examine the damaged plane, taking specimens of the material and also securing photographs of the wreck and surrounding territory when it is believed that such specimens or photographs would be of assistance to the Crash Board in reaching its conclusions. The report of the inspector, together with all accompanying exhibits, is then submitted to the Crash Board. This board consists of six members: Two supervising inspectors who are stationed at the headquarters in Washington, the medical director or in his absence his assistant, a representative of the Engineering Section, the chief of the Enforcement Section, and the chief statistician. Over half of the members of the board are qualified pilots and all of them have had considerable experience in aero-

nautical matters. This board proceeds to determine the causes of the accident and apportion percentages to the various factors involved. In case of disagreement, averages are taken.

The results on chart 11 represent the opinions of this board. It is interesting to note that 55.79 per cent. of all accidents during the period were charged to "errors of pilots." This clearly indicates that more rigid examinations should

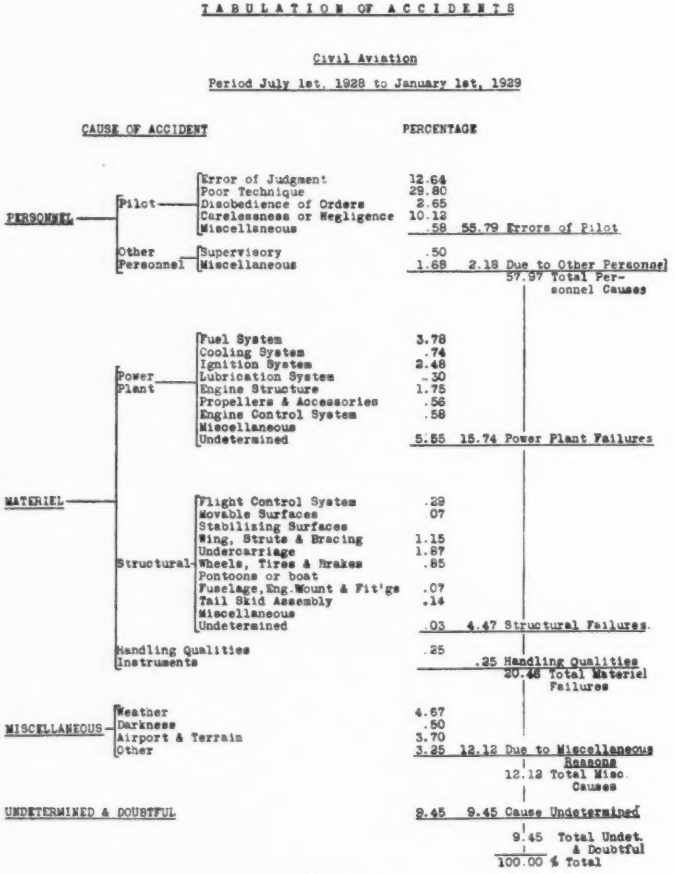


FIG. 11.

be given to applicants for pilots' licences and also that improvements should be made in the training of civilian pilots. You will recall that the Air Commerce Act requires only aircraft and personnel engaged in inter-State commerce to secure licences. Students' instruction in practically every instance is confined within the borders of a single State. Therefore, at the outset, the department was not in a position to regulate the civilian flying schools other than to provide that of those pilots holding federal licences, only transport pilots could give flying instruction for hire or reward.

However, there was a general demand that the department should have some supervision over the schools. After the facts which appear on chart 11 were made public, the Air Commerce Act was amended so as to authorise the Secretary of Commerce to examine and rate civilian flying schools, provided these schools made an application for such examination and rating. While it is not

-- Page 2 --

VITAL STATISTICS		NUMBER OF ACCIDENTS	
KIND OF FLYING	Schedule Flying (Airway)	51	
	Student Instruction	65	
	Experimental	32	
	Miscellaneous(Commercial)	191	
	Miscellaneous(Pleasure)	333	672 Accidents
PILOT	Licensed	361	(1)
	Letter of Authority	86	(1)
	Unlicensed	225	
	Average Age of Pilots	28.9	Years
	With Medical Waiver	31	
	Without Medical Waiver		
	Fatal Injury Class "A"	88	
	Severe Injury Class "B"	91	
	Minor Injury Class "C"	101	
	Uninjured Class "D"	392	
PASSENGER	Fatal Injury Class "A"	127	
	Severe Injury Class "B"	98	
	Minor Injury Class "C"	106	
	Uninjured Class "D"	368	
AIRCRAFT	Licensed	338	
	Temporary Number	209	
	Not Licensed	125	
	Completely Demolished "A"	287	(2)
	Complete Overhaul "B"	159	
	Major Assembly Repairs "C"	165	
	Minor Repairs "D"	54	
	Not Damaged "E"	7	
NATURE OF ACCIDENT	Class "A" Collision	6	
	Class "B" Collision	60	
	Class "C" Engine Failure	37	
	Class "D" Without Engine Failure	144	
	Class "E" Forced Landing	143	
	Class "F" Landing Accidents	139	
	Class "G" Take Off Accidents	78	
	Class "H" Taxying	17	
	Class "I" Fires in the Air	5	
	Miscellaneous Class "L"	42	
	Unknown and Doubtful "M"	1	
LIGHTER-THAN-AIR CRAFT			
	TOTAL NUMBER OF ACCIDENTS REPORTED	672	

(1) See table on page 3
(2) There were 26 cases of fire after crash in this group.

FIG. 11A.

compulsory under the law that schools have a rating from the department, there is every indication that competition, in conjunction with State legislation, will practically force all of them in the near future to secure such a rating. The regulations governing the examination and rating of flying schools were promulgated last April and the task of carrying out the mandate of the amendment to the Act is just getting well under way. Sufficient time has not yet elapsed for the results to become apparent, but all are confident that this represents a forward step in making aviation much safer.

The careful analysis of all aircraft accidents of commercial types of aircraft affords an opportunity to determine those factors in the design and operation of aircraft which demand improvement.

As an example, I will take a period of six months, from July to December, 1928, during which time 672 accidents were reported (Chart 12). The accidents to aeroplanes with cause are as follows:—

Collision—full flight—with other aircraft	6
Collision with other than aircraft	60
Loss of speed following engine failure	37
Loss of speed, not due to engine failure	144
Forced landings	143
Landing accidents	139
Take-off accidents	78
Taxying accidents	17
Fires in the air	5
Miscellaneous	42
Unknown and doubtful	1

From these figures it appears that 80 per cent. of the accidents during that period were due to the following causes:—

Loss of speed (stall)	181
Forced landings	143
Bad landings (not forced)	139
Bad take-offs	78
Total ...	541

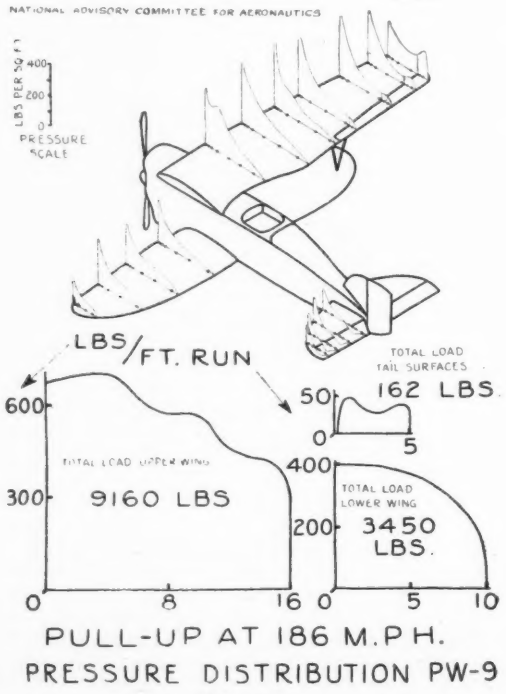


FIG. 12A.

The general conclusions that can be drawn from the above figures are :— First, that the modern aeroplane is too easily stalled; second, that it is too hard to land; and third, that it is too hard to take-off.

The National Advisory Committee for Aeronautics, in preparing its research programme, has considered the analysis of aircraft accidents, and has included a programme of research intended to improve the safety of aeroplanes from the standpoint of aerodynamics. In accordance with this programme of aerodynamic safety the Committee is studying the stability, controllability, manœuvrability, landing and take-off, and spinning characteristics of aeroplanes.

Studies are also being made of ice formation in flight and of gusts.

For the improvement of aerodynamic efficiency the Committee is studying the problem of aeroplane performance and the subjects of increased lift and decreased drag.

Although there have been very few accidents to commercial aeroplanes as a result of structural failures, the National Advisory Committee is planning to extend the work on the determination of the aerodynamic loads and load distribution to commercial type aeroplanes.

A study of the loads supported by the structures of aeroplanes of military types has been carried on for the last three or four years and has reached the furthest development in the tests on the PW-9 Boeing pursuit type aeroplane. The Advisory Committee, in investigating the pressure distribution over the

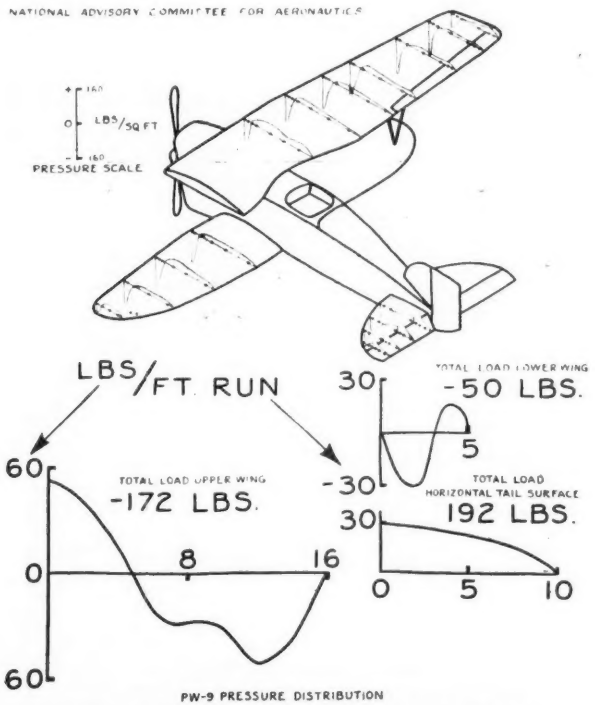


FIG. 128

PW-9 aeroplane, not only included the wings, tail surfaces, and the control surfaces, but investigated the pressure distribution over the fuselage.

Fig. 12A shows graphically the pressure distribution obtained on the wings of the PW-9 in a pull-up at 186 miles per hour, indicating the maximum intensity of pressure at the leading edge of the upper wing to be over 400 pounds per square foot. The figure also shows the total load on the upper and lower wing of the biplane structure and the span loading.

Fig. 12B shows the maximum pressure imposed and the distribution of pressure over the wings in a pull-down at 160 miles per hour. The small black points on the wing surfaces and on the tail surfaces indicate the small orifices at which pressures were measured.

Fig. 12C is interesting, as it shows the distribution of the load on the PW-9 in a pull-up at 186 miles per hour, where the acceleration registered is 9 g. The weight of the aeroplane is 3,000 pounds. The total load on the structure in this manœuvre was 27,000 pounds, of which the upper wing took 18,300 pounds, the lower wing 6,700 pounds, the fuselage 1,650 pounds, and the tail 350 pounds. In the upper portion of this figure is a chart showing the pressure distribution over the fuselage from the nose to the tail in this particular manœuvre.

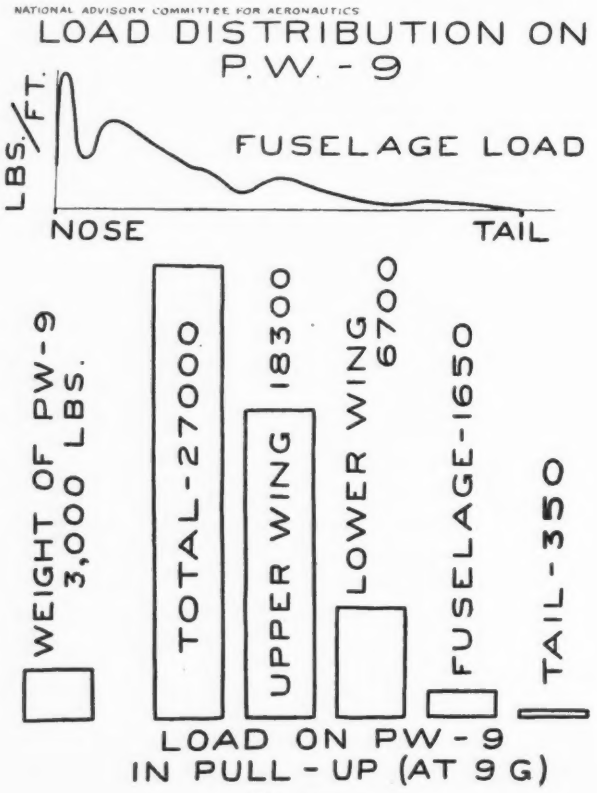


FIG. 12C.

The National Advisory Committee plans to investigate in as thorough a manner the pressure distribution on commercial types of aeroplanes. I appreciate that commercial aeroplanes are not expected to be subjected to the kind of treatment that the PW-9 received, and that at the present time there is a lack of information on the structural conditions under which commercial aircraft have to work.

There is also a lack of information on the loads really imposed in flying under severe weather conditions or in rough country. It will be of considerable value to designers of aircraft if the maximum loads under which transport aeroplanes must work can be determined, especially when operating over mountains or under the most unfavourable weather conditions. It is important that a study be made to include the measurement of the total load and of the load distribution on both biplanes and cantilever type monoplanes.

The results of these investigations will have an important bearing on the regulations affecting the stress analysis of commercial type aeroplanes, as indicated by Fig. 12D, where the span loading on the PW-9, together with the bending moments, is compared with the specifications for this particular type of aeroplane. The span loading as determined in flight is indicated by the full line and the specified loading by the dashed line.

The study of pressure distribution has been extended to include the determination of water pressures on seaplane boats and floats with various types of landing gear. This information will, of course, be extended to commercial

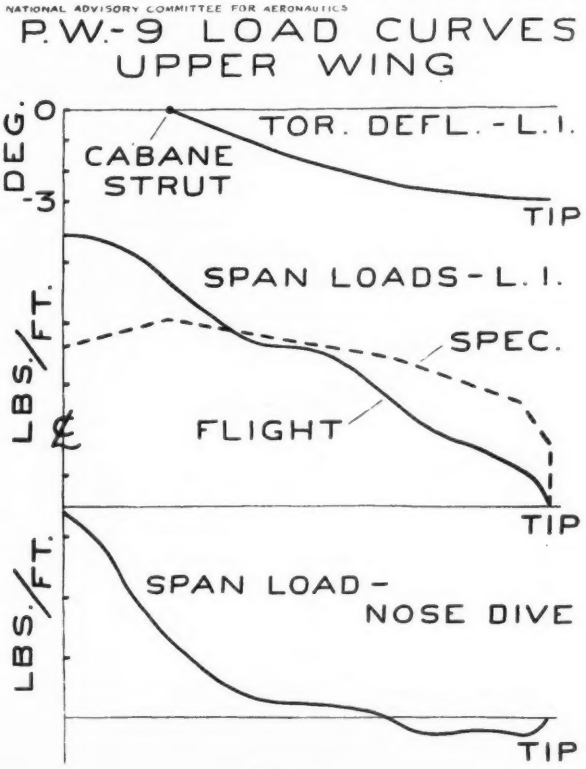


FIG. 12D.

type seaplanes and will have an important bearing on the design of the structure of a seaplane float.

Fig. 12E indicates the maximum pressure and the pressure distribution obtained in flight tests on a twin-pontoon Navy seaplane. The maximum pressures indicated are about nine pounds per square inch, which, as will be seen from the chart, occur at the step and near the stern of the pontoon.

Another example of the problems being studied by the National Advisory Committee in connection with the determination of the loads on an aeroplane structure is shown in Fig. 12F. In making a study of landing gear characteristics a comparison has been made of the load transmitted to the fuselage when using the Oleo type shock absorber and when using a rubber type shock absorber. The chart indicates the amount of load transmitted to the fuselage with both types of shock absorber in a normal, a two-point, and a pancake type of landing. In all cases the Oleo type of shock absorber transmits only about one-half of the load to the fuselage that is transmitted when a rubber type shock absorber is used. This work is increasingly important if imperfect landings are made.

As mentioned before, most of the investigations to determine the aerodynamic loads on the aeroplane structure in flight and in landing have so far been conducted on aeroplanes of the military type. The instrument equipment and our technique in conducting such investigations have been developed to a point where it will be comparatively easy to extend the investigations to

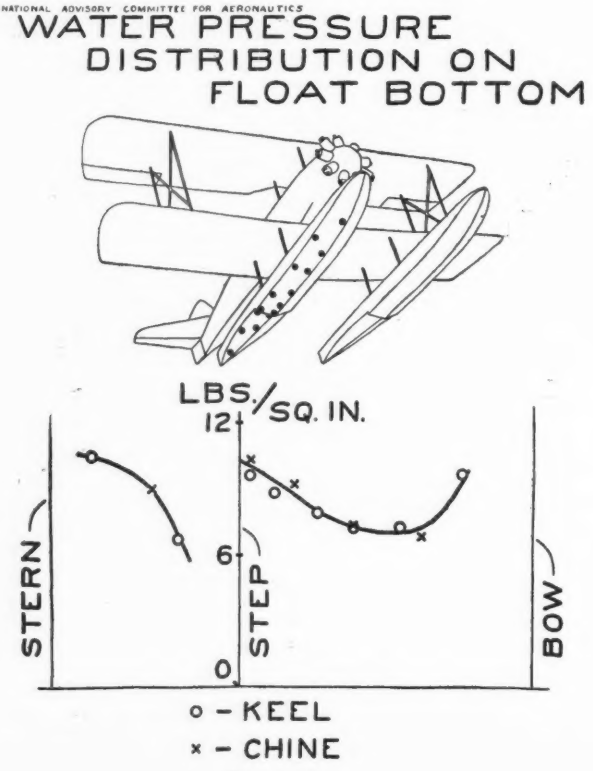


FIG. 12E.

commercial aeroplanes of different types. With the information obtained from such investigations the regulations governing stress analysis can be drawn so that in the future the factor of safety will be such that structural failures will be greatly decreased, and if they do occur they will probably not be due to using a too low design factor but to imperfect workmanship or material.

The experience we have had in America with peculiar and dangerous spins of aeroplanes of widely different types has necessitated the study of the spinning problem from every angle. The accidents recorded as a result of spins are due in a large measure to an aeroplane stalled in such a position that recovery is not possible, although the spin in most cases is of the so-called " normal " type.

One problem which is regarded as of very great importance from the standpoint of safety is that of the " flat " spin, so called because the aeroplane spins with its longitudinal axis at an angle close to the horizontal. We have had a number of cases of aeroplanes falling from a normal to a flat spin after two or three turns. In most cases it was impossible to recover control of the aeroplane from the flat spin.

It is commonly recognised that there are two separate systems of forces at work on an aeroplane in a spinning manœuvre, the aerodynamic and the mass or inertia forces. As an example, I will cite our experiences with the NB training type seaplane.

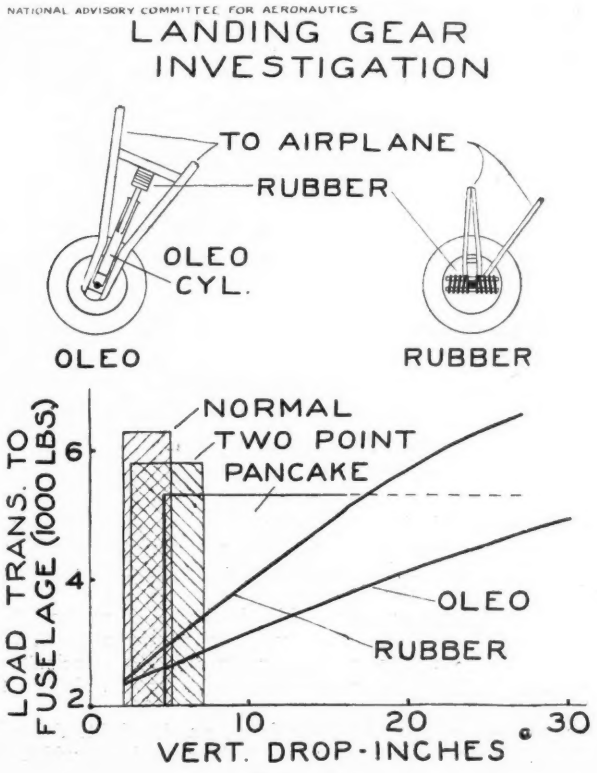


FIG. 12F.

There are a number of instances where this type of aeroplane crashed as a result of a flat spin. The rate of descent, however, was so slow that in no case was the result of the crash fatal to the pilot or the observer. At the end of the lecture I will show a motion picture film of a flat spin with this type of aeroplane, from the beginning of the spin to the crash, which resulted from being unable to bring the aeroplane out of the spin. In this particular case a change had been made in the controls, and the pilot felt quite confident that he could regain control of the aeroplane in the spin, so the crash was entirely unintentional. As a result of the crash the pontoon was destroyed, but neither the pilot nor the observer was injured in any way.

In studying this particular type of aeroplane, free dropping tests were made of models of the aeroplane, demonstrating that the type of spin, flat or normal, could be controlled by shifting weights along an axis of the model.

The mass distribution of the aeroplanes of which we know the type of spin, and particularly all that have a tendency to flat spin, has been determined, and these mass distributions have been studied to discover if any consistent relation between mass distribution and type of spin exists. The method employed in determining the mass distribution of the aeroplane is briefly as follows:—

The aeroplane is swung as a pendulum about several different axes to determine the ellipsoid of inertia of the aeroplane. Without going into detail, it is sufficient to say that the ellipsoid of inertia represents the mass distribution of the aeroplane. The ellipsoid of inertia gives us the principal axis of inertia in a direction with respect to the vertical and horizontal. From this information and from the fact that a solid in revolution tends to rotate about its principal axis, we can determine the type of spin the aeroplane will make if acted upon only by the dynamic forces due to its mass.

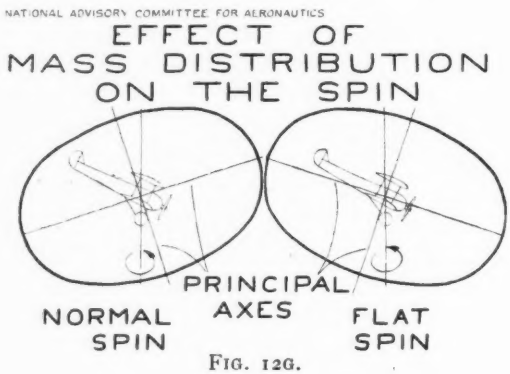


FIG. 12G.

Fig. 12G illustrates this in a general way. The ellipse shown at the left is the ellipse of inertia of the aeroplane. We need only to consider the ellipse rather than the solid ellipsoid, since the aeroplane is symmetrical about a vertical plane through the longitudinal axis.

Take the case of the normal spin, which is the figure at the left. The spin axis is vertical, and, remembering that the aeroplane tends to rotate about one of its principal axes, it can be seen that in this case the principal axis tending to become vertical depresses the nose of the aeroplane, which is the case in the normal type of spin.

In the second case, as shown by the figure on the right, the principal axis tending to become vertical raises the nose of the aeroplane, which results in a flat spin.

In a general way, we may see that an aeroplane whose mass distribution is similar to that of the figure on the left will have normal spinning characteristics, and an aeroplane having a mass distribution similar to that of the figure on the right will have a tendency to flat spin.

In the motion picture, following the spinning of the actual aeroplane, you will see the results of free dropping tests of a model of the aeroplane having the same mass distribution and the same wing loading. By shifting weights along the axis of the aeroplane, the ellipsoid of inertia representing the mass distribution can be made to conform to either of the figures shown on Fig. 27, with the result that the spin will be normal in one case and flat in another.

I have outlined one or two investigations of a programme of research that is being undertaken as a result of our experience in the analysis of accidents to commercial types of aeroplanes. We shall strive to take advantage in every way of what we learn from accidents, in planning our further research programme. From our present analysis more than half of all air accidents are attributable to the pilot, resulting from stalls, spins, landing, and taking off.

Our final aim is to make the aeroplane capable of assuming a much greater share of the responsibility for safe flying than it can assume at present. The extreme safety requirements of the aeroplane for the private owner can be considered as a most effective guide in planning our research programme.

While our experience in accident analysis has been rather limited, it is interesting to compare the results of the board during various periods. This will be found in graphic form in chart 13. The first period covers the full year

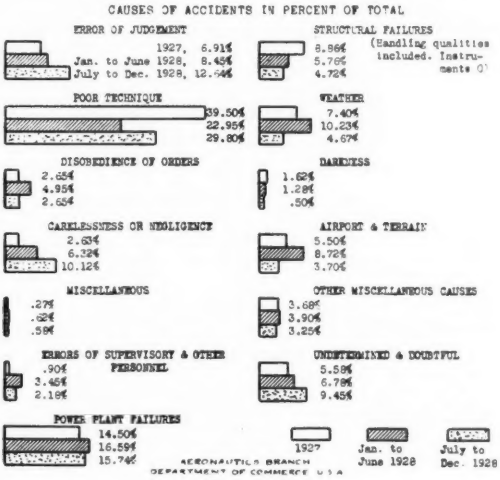


FIG. 13.

of 1927, the second one the first six months of 1928, and the third one the second six months of 1928. It should be remembered that during the first two periods this board did not have the benefit of the National Advisory Committee for Aeronautics' Accident Analysis Report, but the Act required that the work be done and the Board used methods somewhat similar to those presented by the Report.

It is interesting to note the accidents attributable to structural failures. Adverse weather, darkness, airports and terrains all show a constant decrease indicating a steady improvement in the design and manufacture of planes and the construction and maintenance of air navigation facilities.

With the supervision of pilots' training, accidents due to errors of judgment and poor technique should also decrease. However, it must be borne in mind that in analysing the accidents you always arrive at a total of 100 per cent. Therefore, these charts cannot be relied upon to indicate the true progress which is being made in improving the safety of aerial operations. While chart 12 sets forth numerically the classification of the nature of the various accidents for a six months' period, it is interesting to compare relatively the number of the various types of accidents and their tendency to increase or decrease with reference to the whole. This appears in chart 14, which covers the same three periods treated in the preceding chart. It will be noted that the greatest percentage of accidents is due to spins and stalls with or without engine failure. However, the accidents caused by spins and stalls with the power plant functioning properly show a steady tendency to decrease. This is due to the results of the scientific studies which have been made to more effectively control the planes at or under stalling speeds. The department now requires that all the smaller types of planes must be spun six turns and recover when the controls are released.

Next in importance to spins and stalls are take-off and landing accidents. The latter are divided into two classes: those resulting from forced landing and those occurring under normal conditions. The percentage of accidents due to forced landings is relatively high. While not all forced landings are caused by power plant failure there is a close similarity between the percentage under forced landings on chart 14 and power plant failures on chart 13.

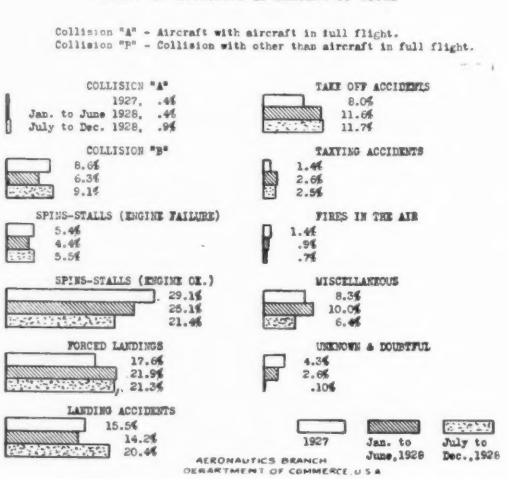


FIG. 14.

It is quite apparent that the pilot is at the present time the most important factor in safe air transport. It is, therefore, interesting to study the experience of pilots with reference to their own fatalities. We have made such study and the results appear on chart 15. The curve shows clearly that the critical period for a pilot is during his first 600 hours in the air. At that point the curve begins to flatten out, and by the time that it reaches 1,500 hours it becomes practically a straight line. This chart was compiled from the experience of commercial pilots. Similar charts have been plotted for the pilots of the Army Air Corps and the Naval Bureau of Aeronautics. They indicate the same characteristic curves.

During the past four years a trophy has been awarded annually to the naval pilot flying the greatest number of hours without injury to personnel or material. In each case the trophy has been won by the pilot having the greatest number of hours of flying. At the time of the last award it was suggested that the conditions be altered so as to award the trophy to a squadron rather than to an individual. If this change is made it will be interesting to note whether the same results will be obtained with reference to a group as has been the case during the past four years when the records of individuals alone were the determining factor.

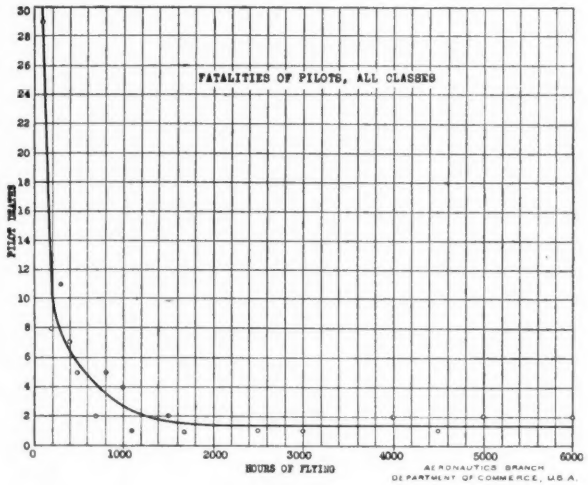


FIG. 15.

As was previously pointed out, the analysis of accidents has been on the basis of 100 per cent. It is important to know the relation between the total number of accidents and the total number of planes and pilots. This study has been made, and is depicted in chart 16. From it you will note that the curves representing licensed pilots and licensed planes curve sharply upward during the year 1928. Curves indicating identified or unlicensed planes curve up only slightly, and the same is true of the total number of accidents of all classes. A somewhat similar study was made on the basis of flying time and hours, and is depicted in chart 17. Unfortunately, this chart is a little bit complicated, due to the fact that it deals with the number of accidents, total fatalities, number of hours flown with cumulative totals from July 1, 1927, and also totals for the year 1928. However, it is encouraging to observe that the flying time per fatal accident has increased from 650,000 hours at the beginning of the year to nearly 800,000 at the end of the year.

The curve representing the cumulative total of all accidents is more or less constant, as is the similar curve for the year 1928. However, the three lower curves depicting the fatalities, the figures for which are inside the chart instead of on the margin, are comparatively flat, and decidedly favourable to licensed pilots as compared to all pilots.

From this study of aircraft accidents it should be possible for us to determine the weak points in the existing air regulations or in the technical development and construction of aircraft. It is our hope that similar methods will be adopted by the aeronautical authorities of other countries, thus permitting a composite analysis of all aircraft accidents on the same basis.

While safety is of primary importance in air transportation, if civil aviation is to develop on a sound economic basis, it must be able to render a service worth more to the user than the cost to the operator plus a reasonable profit. Speed is a factor which vitally affects the value of the service and the cost of

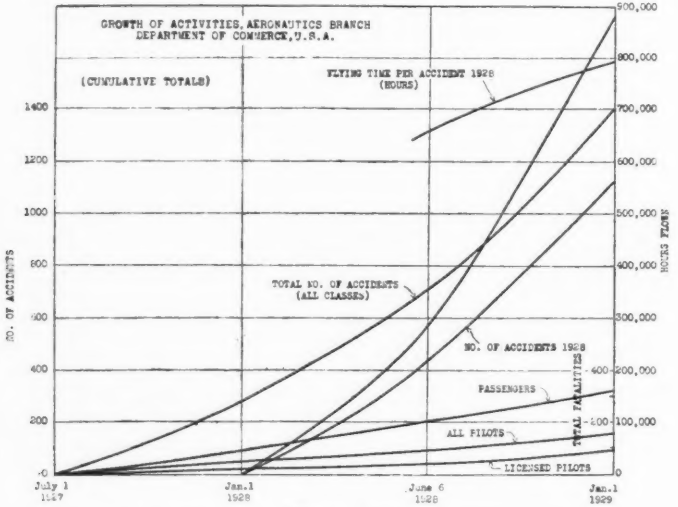


FIG. 16.

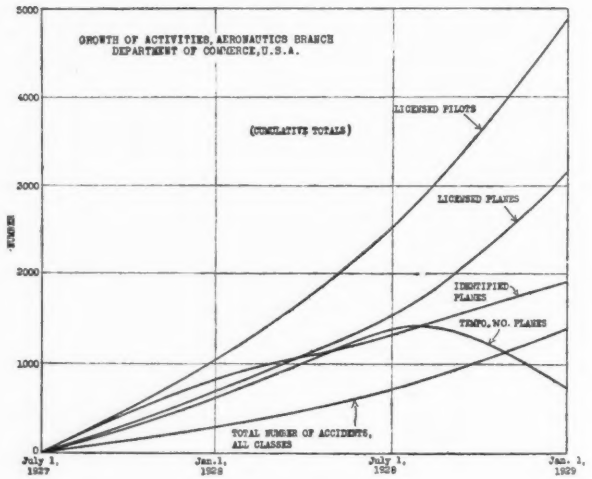


FIG. 17.

performing it. A very interesting and important study was undertaken a little over a year ago by the scientists on the staff of the National Advisory Committee for Aeronautics. It had to do with reducing the parasite resistance of radial air-cooled engines. By means of full scale wind tunnel tests a new cowling was developed for this particular type of engine. When the tests were

TRANSCONTINENTAL AIR TRANSPORT.
Work Completed ▨ Work Being Done By Others □ Work Still to Be Done

TRANSCONTINENTAL AIR TRANSPORT.
Work Completed
Work Being Done By Others
Work Still to Be Done
Columbus
Indianapolis
St. Louis
Kansas City
Wichita
Waynoka
Clovis
Albuquerque
Winslow
Kingman
Barstow
Los Angeles
San Francisco

FIG. 18.

actually made in the air the results achieved were most satisfactory. The new cowling increased the speed of the plane equipped with a single engine of 220 h.p. from 15 to 20 miles an hour without any increase in engine speed or fuel consumption. Obviously, this not only reduced the cost to the operator but enabled him to render better service to his customers.

However, the most important study which has been conducted with reference to power plants is the one pertaining to the development of the Diesel engine. While there are indications that this problem is well on the way to solution, I am not in a position at the present time to give any detailed information as to what has been accomplished.

As was mentioned in the beginning, the contributions of science to the development of civil aviation have not been confined to the fields of aerodynamics and internal combustion engines. As has been truly stated, an airway begins and ends on the earth's surface and all of the equipment for the airway must be located thereon. A striking illustration of the number of items involved in laying out such an airway will be found on the progress chart of the Trans-Continental Air Transport (chart 18). This chart was prepared by engineers of

FIG. 18.

that company which, as you know, is now operating a combined air and rail service between New York, Los Angeles and San Francisco. There are eleven intermediate stops between the three terminals and nearly a hundred different items to be attended to at each terminal and intermediate stop. This involves the selection and acquisition of the site, lights, buildings, wireless, meteorological service and communication systems, each of which requires scientific study if the best results are to be obtained. Likewise, practically all of them have some bearing on the five fundamental factors upon which the success of civil aviation depends. It is obvious that with such a diversity of problems confronting this newest method of air transportation, the closest co-operation not only between the scientists and the Governmental authorities is essential, but co-operation between all those interested in the solution of these problems.

The field is international as well as national in scope. The truth of this statement is well demonstrated by this occasion. This meeting is held in England under the auspices of the Royal Aeronautical Society. The lecture is dedicated to the memory of an American, Wilbur Wright, who, with his brother Orville Wright, first demonstrated the practicability of man navigating the air in a power-driven heavier-than-air machine. The date selected is the twentieth anniversary of the first great international flight. It was made by Louis Blériot, a Frenchman, from Calais to Dover, across the English Channel. As an illustration of the youthfulness of this art, it can be pointed out that both Orville Wright and Louis Blériot are still actively engaged in applying their efforts and genius to the advancement of the science in which they were pioneers. Thus it is certainly apparent that the promotion and regulation of civil aviation presents one of the most fascinating scientific as well as economic and administrative problems of our age.

At the conclusion of the lecture Professor F. W. Lanchester proposed and Lieut.-Colonel J. T. C. Moore-Brabazon seconded a vote of thanks to the lecturer.

SUMMARY OF THE SOCIETY'S ACTIVITIES

DECEMBER 1928—DECEMBER 1929

The following places on permanent record in the Journal such notices which have appeared in the Monthly Notices inset in the Journal, and so summarises the Activities of the Society for the year.

COUNCIL, 1929—1930

President

At a meeting of Council held on May 15th, 1929, Colonel The Master of Sempill, A.F.C., A.F.R.Ae.S., was re-elected President for the year October, 1929-September, 1930 under Rules 78 and 80.

The following is an extract from the Council minutes:—

> "Having considered Rules 78 and 80 in conjunction with the previous records of the Society, the Council consider they are correct in accepting the nomination of Colonel the Master of Sempill for the Presidency."

Vice-Presidents

At a meeting of Council held on May 15th, 1929, Air Vice-Marshal Sir Vyell Vyvyan, Lieut.-Colonel J. T. C. Moore-Brabazon, and Mr. H. E. Wimperis were elected Vice-Presidents for the year October, 1929-September, 1930 under Rule 84.

As results of the ballot held in March for election the following is the Council for the year April, 1929-March, 1930:—

President.

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S.

Past-President.

Air Vice-Marshal Sir W. Sefton Brancker, K.C.B., A.F.C., F.R.Ae.S.

Vice-Presidents.

Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O.
Lieut.-Colonel J. T. C. Moore-Brabazon, M.C., F.R.Ae.S., M.I.Ae.E., M.P.

Council.

Captain P. D. Acland.
Major T. M. Barlow, M.Sc. (Eng.), M.Inst.C.E., M.I.Mech.E., F.R.Ae.S.
Mr. Robert Blackburn, F.R.Ae.S.
Mr. M. L. Bramson, A.C.G.I., A.F.R.Ae.S., M.I.Ae.E.
Mr. Griffith Brewer, F.R.Ae.S.
Major J. S. Buchanan, O.B.E., A.M.I.Mech.E., F.R.Ae.S.
Wing Commander T. R. Cave-Browne-Cave, C.B.E., A.M.I.Mech.E., A.M.I.N.A., F.R.Ae.S.
Captain F. T. Hill, F.R.Ae.S., M.I.Ae.E., B.Sc., Wh. Ex.
Captain A. G. Lamplugh, F.R.Ae.S., M.I.Ae.E.
Major A. R. Low, F.R.Ae.S.
Mr. W. O. Manning, F.R.Ae.S.
Major R. H. Mayo, O.B.E., F.R.Ae.S.
Mr. F. Handley Page, C.B.E., F.R.Ae.S.
Mr. T. O. M. Sopwith, C.B.E., F.R.Ae.S.

Mr. C. C. Walker, Assoc.M.Inst.C.E., F.R.Ae.S.
Mr. H. E. Wimperis, O.B.E., F.R.Ae.S. (Vice-President elect).
Mr. L. A. Wingfield, M.C., D.F.C., A.R.Ae.S.I.
Mr. R. McKinnon Wood, M.B.E., A.M.Inst.C.E., F.R.Ae.S.

Hon. Treasurer: Major D. H. Kennedy, O.B.E., F.R.Ae.S.
Hon. Librarian: Mr. J. E. Hodgson.
Hon. Accountant: Mr. A. N. D. Smith, F.I.C.A.

Committees of Council

The following are the Committees of Council for the year April, 1929-March, 1930:—

GRADING COMMITTEE.

Mr. R. Bruce.
Captain Barnwell.
Major F. A. Bumpus.
Captain F. T. Hill.
Dr. H. C. Watts.
Major A. R. Low.
Prof. B. Melvill Jones.
Mr. P. A. Ralli.
Major F. M. Green.
Captain G. S. Wilkinson.
Colonel L. F. R. Fell.
Mr. W. P. Savage.
Mr. R. V. Southwell.
Mr. A. Gouge.
Mr. R. J. Mitchell.
Mr. E. F. Relf.
Mr. J. D. North.

FINANCE COMMITTEE.

Major D. H. Kennedy.
Mr. J. E. Hodgson.
Mr. A. N. D. Smith.
Mr. L. A. Wingfield.
Mr. C. R. Fairey.
Mr. F. R. Simms.
Captain F. T. Hill.

INFORMAL DISCUSSIONS COMMITTEE.

Mr. M. L. Bramson.
Major J. S. Buchanan.
Mr. F. A. Foord.
Major R. H. Mayo.

MEDALS AND AWARDS COMMITTEE.

Mr. Griffith Brewer.
Major J. S. Buchanan.
Major T. M. Barlow.
Mr. A. H. R. Fedden.
Wing Cmdr. G. B. Hynes.
Mr. W. O. Manning.
Mr. C. C. Walker.
Mr. G. R. Volkert.
Sir Alliott Roe.
Mr. L. A. Wingfield.
Mr. R. McKinnon Wood.

JOINT STANDING COMMITTEE WITH THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS, THE ROYAL AERO CLUB AND THE AIR LEAGUE OF THE BRITISH EMPIRE.

Mr. Griffith Brewer.
Colonel the Master of Sempill.
Air Vice-Marshal Sir Vyell Vyvyan.

LECTURE SUB-COMMITTEE.

Major J. S. Buchanan.
Major T. M. Barlow.
Mr. Robert Blackburn.
Mr. A. E. L. Chorlton.
Mr. F. T. Hill.
Major A. R. Low.
Mr. W. O. Manning.
Captain J. Laurence Pritchard.
Colonel the Master of Sempill.

REPRESENTATIVES ON OTHER BODIES.

British Engineering Standards Association Aircraft Committee.—Major R. H. Mayo and Dr. H. C. Watts.

Central Library for Students.—Mr. J. E. Hodgson.

Association of Special Libraries and Information Bureau.—Mr. J. E. Hodgson (Hon. Librarian).

Students' Section.—Mr. T. Tanner (Honorary Secretary).

Mr. C. R. Fairey

At a Council Meeting held on Tuesday, April 16th, 1929, the following resolution was unanimously passed:—

"That the Council wish to express their very deep appreciation of the valuable services rendered by Mr. C. R. Fairey during the years he has been on the Council. The Council are particularly mindful of the fact that Mr. Fairey was instrumental in the first instance in obtaining the financial support of the S.B.A.C. It is their earnest wish that the Council may be able to call on Mr. Fairey on occasions of very special importance."

ELECTIONS

The following were elected members of the Society in the grades indicated on December 10th, 1928:—

Fellows.—Robert Arthur Bruce (transferred from Associate Fellow), Cecil Hugh Latimer Needham (transferred from Associate Fellow), George Tilghman Richards (re-elected).

Member.—George Tilghman Richards (re-elected).

Associate Fellows.—Alfred Charles Brown, Albert Thomas Cross, Victor Reginald Scriven.

Associate Members.—Sydney Baldwin, John Sharples Charnley, Thomas Courtenay Head, Harold Bertram Pond.

Associates.—Joseph William Hay Barrett (transferred from Student), William Thomas Harriden, Harold Parkinson, Frank Horsfield Spencer, Frank Whittle.

Student.—Purshottam Meghji Kabali.

Companions.—Sydney Goldstein (transferred from Student), Madame de Landa.

On January 9th, 1929:—

Fellows.—Mogens Louis Bramson (transferred from Associate Fellow), Reginald Joseph Mitchell (transferred from Associate Fellow), Joseph Lawrence Nayler (transferred from Associate Fellow), Ernest Ower.

Associate Fellows.—Albert Arthur Hammond (transferred from Student), James Kewley, Arthur Cyril Thornton, Theodore Paul Wright.

Associate Members.—George Oswald Anderson, Archibald Henry Harrison.

Associates.—Cyril Gordon Burge, Alfred Leonard Ford (transferred from Student), Harry Higgins.

Students.—Clement James Selden, John Emmerson Walker.

On February 5th, 1929:—

Associate Fellows.—Isidor Levy (transferred from Student), Christopher Noel Hunter Lock, Frank Morgan Owner, Robert Allan Powell.

Associate Members.—John Alexander McCulloch (re-elected), Herbert Percival Strong.

Associate.—Thomas Henry Turner.

Students.—Walter Patrick Dillon Bennett, Frederick Henry Carey, Christopher Ainsworth Davis, Edward Lucas Mole, Robert John Feltham Waight.

Companions.—Charles Edward Thomas Maguire (transferred from Student), Richard Oliver Irving Muntz, A. F. Sidgreaves, A. R. Stevenson, Jun. (re-elected).

On March 19th, 1929:—

Associate Fellows.—Sydney Brew, John Adrian Chamier, Harold Henry Holmes, Gustav Victor Lachmann, John Watson Maccoll (from Student), Norman McCirrick, Norman MacMillan, Reginald John Penn, John Henry Powle (from Student), Alfred Drummond Warrington-Morris.

Associate Members.—Arthur George Adams, Gervase Balfour Bennett, Joseph George Navarro.

Associates.—Carlos Manuel Gadda, Earl McNabb Hand, Seymour Cunningham Redshaw, Arthur Richard Seabrook.

Students.—Henry Robert Free, Earl Hoey, Geoffrey John Eliot Howard, Edward Johnstone Langan, Michael Longridge, Kenneth Wilson Marshall, William Richard Massey, Clifford Mapp, Errol William Seymour-Hosley.

Companions.—Carl de Ganahl, Marcos A. Zar, St. John Tempè Plevins.

On April 16th, 1929:—

Associate Fellows.—Harry Bateman, Basil Binyon, Harry Edgar Broadsmith (re-elected), George Burrell Fenton (transferred from Student).

Associate Member.—George Neville Bradley Richards.

Associates.—Charles Neville Colson, Donald Vernon Irvins.

Student.—James Purkis Smith.

On May 15th, 1929:—

Fellows (from Associate Fellows).—James Bird, Edward Featherstone Briggs, Leopold William Bryant, Alan Ernest Leofric Chorlton, Robert Alexander Frazer, Norman Augustus Victor Piercy, David Randall Pye, George Shakespeare Wilkinson.

Associate Fellow.—Francis William Musson.

Associates.—Colin Layzell Apps, Richard Bernard Brigham, Sidney Charles Hett, Frederic Pilling, George Tom Willey.

Students.—Walter Stuart Coleman, John Freeman Cuss, Anthony Christopher Loraine Rendel, William David Sherriff, Thomas Horsfall Wood.

Companions.—Joseph Russell Knowles, Joseph Dawson Paul, Junichiro Yamashita.

On June 11th, 1929:—

Fellows (Re-graded from Associate Fellows).—Vincent Crane Richmond, Frederick Sigrist.

Associate Fellows.—Lester Durand Gardner, Henry Knowler (re-elected), Alan Sidney Lane.

Associate Members.—Reginald Collis, Anthony Frank Lago.

Associates.—Frank Rodney Baldwin, Alfred Carey Clinch.

Students.—Richard J. Jackson, Maurice Tudor Judson, Gerald Patrick King, Albert H. Lawrence, George Nelson, Robert Francis Rowe, A. I. Ryness, Alfred Lee Tyler, Leonard Ward, Leonard Seymour Werry, Clement Edgar Wood, Reginald Thomas Wood.

Companion.—Leonard S. Horner.

On July 10th, 1929:—

Associate Fellows.—J. H. Crowe, Claudius William Pidcock.

Associates.—Vivian Gwilym Jones, Maurice Downer, John Collingwood Goldie.

Students.—Ronald George Buck, Richard E. Drake, Herbert Belton Sharman, Cyril Williamson.

On September 10th, 1929:—

Fellow (Re-graded from Associate Fellow).—Alfred Gilmer Lamplugh.

Associate Fellows.—John Herbert-Jones, John Leslie Hutchinson, William Henri Miller, Mono Mohon Roy, Maurice Edward Arthur Wright.

Associate Member.—William Munro.

Associates.—James Valentine Connolly (re-graded from Student), Elwyn Derek Crisp, John Robert Currie, James Alfred Heckman, Frederic Wyndham Freke Hewitt, Frederic Charles Rayner Jacques, Alfred Ernest Mitchell, James Allan Mollison, Frederick George Ernest Molony, Henry Maitland Thomas.

Students.—Clifford Claude Caple, Harold Fontayne Chester, Reginald Joseph Cohen, Henry Hargan Davis, Joseph Dobson, Frank Steight Gardner, William Joseph Hickey, Victor Henry Frederic Hopkins, John Balfour Murray, Arthur Franklyn Pain, Eric Shaw, Edward Lumly Delpratt White, Eugene Wieser.

Companions.—Gladys Cottrell, Charles Delme-Radcliffe, John Charles Bradley Firth, Eardley Holland, J. J. Stodart Kennedy.

On October 8th, 1929:—

Fellow.—Horatio Barber (re-elected).

Associate Fellows.—Kenneth Watson Clark, John Myles, Sydney James Waters (re-elected).

Associate Member.—Alan Theodore Eden Eadon (re-elected).

Associates.—Thomas George Barton, Edmund Neil Boileau Bentley (from Student), James Edward Blum (from Student), Albert Edward Clifford, John Purvis Gibb.

Students.—Gerald Napier Ashcroft, George W. G. Brammer, John Joseph Green, Jack Hedges, Lancelot Elworthy Jarman, Elsie Joy Muntz, Derek Price, Henry Cyril Robinson, Frederick William Sainsbury, Frank Wattendorf.

Companions.—Alexander Duckham, Amy Johnson, Alexander Edward Wrottesley Salt.

On November 19th, 1929:—

Associate Fellows.—David Rees Adams, Wilfrid Thomas Davies, Raffaele Giacomelli, Frank Harrison, Walter Glynmore Jennings.

Associate Member.—Eric William Densham.

Associates.—Frederick John Ballard, Brendan John O'Connor Hanstock, Eugene Y. Hsiao, Norman James Lark, Arthur Walter Seeley.

Students.—Charles George Berresford, Herbert John Bigmore, Leslie R. E. Castlemaine, Myles Verney Cave-Browne-Cave, George Cherrington, Leonard Thomas Churcher, Maurice Sidney John Coombes, John Roderick Cromwell-Morgan, John Christopher Denaby, William Howarth Downey, William Garrow-Fisher, Neill McLeod Gibson, James Grenfell, Andrew George Hamilton, Richard S. Hartenberg, Edward John George Jacobs, Henry Louis Jelley, Rupert William Lukey, Glyn Davies Mansel, Robert Frank Murphy, Robert Cromwell Passmore, Joseph Henry Preston, Austin Reed, Charles Arthur Robinson, Harry Roth, William Scott, Edward Graham Seath, Richard William P. Shephard, James Harrison

Skyrme, Alec George Sollis, Robert Alfred Spencer, Denis James Strange, James Alexander Shirreff Thomas, William Francis Thomas, William Thomson, Frank Tyson, Edgar George Vardy, Norman Lynes Walker, Donald Edward Ward, George Herbert Ward, William Edward Wigmore, William Arthur Wildman, John Edward Williams, William Noel Wood, E. V. Wraight, Harold William Yalland, Joseph Zeidenfeld.

Companions.—Geoffrey L. Castle, William Coker Iliffe, Thomas Harvey Searls, Algernon P. Targett-Adams, Florence Margaret Wood, Frank Wright.

Annual General Meeting

The Sixty-Fourth Annual General Meeting of members of the Society was held in the Library at 7, Albemarle Street, W.1, at 5.30 p.m., on Tuesday, March 26th, 1929. Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., President of the Society, was in the chair.

The following members were present:—Captain P. D. Acland, Mr. R. M. Balston, Commander Boothby, Major J. S. Buchanan, Major Bulman, Mr. R. S. Capon, Wing Commander T. R. Cave-Browne-Cave, Mr. C. R. Fairey, Lieut.-Colonel L. F. R. Fell, Mr. H. R. Gillman, Mr. Glaser, Capt. F. T. Hill, Mr. J. E. Hodgson, Capt. Lamplugh, Mr. W. O. Manning, Major R. H. Mayo, Dr. G. Merton, Mr. F. Handley Page, Mr. E. L. Pickles, Flight Lieut. R. Chevallier Preston, Mr. H. P. Savage, Mr. T. O. M. Sopwith, Dr. A. P. Thurston, Mr. F. Tymms, Mr. H. E. Wimperis, and Mr. R. McKinnon Wood.

The notice convening the meeting was read, and the Minutes of the last General Meeting, having been published in the Journal for April, 1928, were taken as read and signed.

The President referred to the slow rate of increase in the membership during 1928, and stated he thought it was due largely to the stiffening of the conditions of entry in the technical grades under the new rules. He pointed out that the number of members elected during the first three months of 1929 gave promise of considerably better figures for the current year.

The Endowment Fund now stood at £1,047, and the President expressed the hope that members would realise the importance of the Fund, the objects of which were to provide a permanent building for the Society and an income for its maintenance.

In commenting on the numerous donations which the Society had received the President mentioned that the Society of Motor Manufacturers and Traders, through the good offices of Mr. F. R. Simms, had repeated their donation of £250, first made in 1928.

After referring to the list of awards printed in the Council's Report, the President said that the Society's Gold Medal, which is the highest honour the Society can confer, was first instituted in 1909, when it was bestowed on the Brothers Wright. Only 5 awards of the medal had been made since that time.

The President expressed satisfaction at the better attendances of members at the lectures. A discussion on the most suitable hour for lectures took place, and the majority of the members present were in favour of keeping to 6.30 p.m., and of strictly limiting the time of reading papers to 40 minutes.

Referring to the Wright celebrations in 1928 the President stated that it was hoped that an American would deliver the Wright Memorial Lecture for 1929 on some date between July 16th and 27th, when the International Aero Exhibition would be taking place.

The President drew attention to the satisfactory way in which the Branches of the Society were proceeding, stating that he had visited several of them in person and had found them doing excellent work, thanks to the energy

of their Chairman and Honorary Secretaries. The one new Branch of 1928, that at Oxford, had made a very good beginning. A new branch had been formed at Bristol early this year and had already over a hundred members.

A very hearty vote of thanks was accorded to Mr. J. E. Hodgson (Honorary Librarian) when the President gave details of the enormous amount of time, labour and invaluable knowledge he had put into the organisation of the Society's exhibit at the International Aeronautical Exhibition at Berlin last year, which resulted in the exhibit having been widely declared the finest that had been seen. If it had not been for the loan of his own valuable prints, books, and other historic objects—all of which, together with the others he had collected for the occasion, he had arranged at his own expense, and at a great deal of personal inconvenience—the result would have been very different.

The President expressed the thanks of the Society to Captain Acland and the Society of British Aircraft Constructors who were giving the Society free space in the Gallery of Olympia for the housing of an historical exhibit at the International Aircraft Exhibition which is to take place between July 16th and 20th. Negotiations with foreign aeronautical societies were in hand, and it was probable that France, Germany, Italy and Sweden would be showing exhibits.

An outline was given of the arrangements being made for the delivery of papers on behalf of the Society during the forthcoming World Engineering Congress at Tokyo. The full list of the papers and the representatives of the Society being :—

DELEGATES TO WORLD ENGINEERING CONGRESS, TOKYO.

Dr. G. V. Lachmann, A.F.R.Ae.S., Technical Adviser to the Ishikawajima Aircraft Works, Tokyo.

Taizo Shoda, Esq., of Messrs. Kokuki Kaisha, Ltd., Atsuta, Nagoya, Japan (Companion).

Major C. H. Chichester Smith, A.F.R.Ae.S., Representative of the Blackburn Aeroplane and Motor Co., Ltd., in Japan.

Professor Aikitu Tanakadate, Zosigayamati, Tokyo-si (Companion).

Anthony Vickers, Esq., of Messrs. Vickers-Armstrongs, Ltd. (Companion).

PAPERS FOR WORLD ENGINEERING CONGRESS, TOKYO.

Authors.	*Titles.*
Mr. W. O. Manning, F.R.Ae.S. ...	"The Development of the Flying Boat in Great Britain."
Mr. A. H. R. Fedden, F.R.Ae.S. ...	"The Use of Air-Cooled Engines for Civil Aircraft."
Squadron Leader E. L. Johnston, O.B.E., A.F.C.	"Air Navigation from the Practical Point of View."
Dr. G. V. Lachmann, A.F.R.Ae.S. ...	"The Development of the Automatic Slot for the Control of Aircraft."
Mr. J. D. Siddeley, C.B.E., F.R.Ae.S.	"The Design, Production and Use of Steel Aircraft."
Major G. E. Woods-Humphery ...	"An Air Route Linking up the Occident with the Orient."
Mr. H. Davis, B.A., A.F.R.Ae.S. ...	"Monoplane *v.* Biplane."
Captain C. E. Ward	"Aerodrome Lighting."

After thanking the Staff and Honorary Officials for their services a short account of the financial position of the Society was given.

The Council's Report for the year 1928-29, and the Balance Sheet and Income and Expenditure Account, as published in the March issue of the Journal, were adopted.

Messrs. Price, Waterhouse and Co. were re-elected Auditors for the ensuing year.

Mr. R. S. Capon, Dr. G. Merton and Flight Lieut. R. C. Preston were appointed scrutineers of the ballot for the election of the new members to the Council. As a result of the ballot the following members were declared elected to serve on the Council for the years 1929-1931 :—Air Vice-Marshal Sir Vyell Vyvyan, Major T. M. Barlow, Mr. R. Blackburn, Mr. Griffith Brewer, Wing Commander T. R. Cave-Browne-Cave, Mr. W. O. Manning, Major R. H. Mayo, Mr. T. O. M. Sopwith, Mr. C. C. Walker and Mr. H. E. Wimperis.

A vote of thanks was accorded to the Chairman and the Scrutineers for their services, and the meeting closed.

LECTURES

The following Lectures were read before the Society in 1929:—

January 10th.—Professor B. Melvill-Jones, A.F.C., F.R.Ae.S., "The Performance of the Streamline Aeroplane."

January 31st.—Mr. W. S. Farren, F.R.Ae.S., M.I.Ae.E., "Monoplane or Biplane?"

February 14th.—Mr. A. H. R. Fedden, F.R.Ae.S., "Air-Cooled Engines in Service."

February 28th.—Mr. R. A. Frazer, B.Sc., A.F.R.Ae.S., "The Flutter of Aeroplane Wings."

March 4th.—Group-Captain H. M. Cave-Browne-Cave, D.S.O., D.F.C., F.R.Ae.S., "The Royal Air Force Far East Flight."

March 7th.—Mr. C. N. H. Lock, "Airscrew Body Interference."

March 14th.—Wing Commander G. B. Hynes, D.S.O., R.A.F., "Engine Performance Tests."

March 18th.—M. Isacco, "The Helicogyre."

April 4th.—Major G. H. Scott, A.F.C., D.S.O., F.R.Ae.S., "The Mooring and Handling of Large Airships."

April 11th.—M. Lapresle, "Wind Tunnel Methods of the Eiffel Laboratory."

April 18th.—Colonel V. C. Richmond, O.B.E., A.F.R.Ae.S., "R.101."

April 25th.—Squadron Leader C. L. Scott, D.S.C., "By Flying Boat to India."

May 6th.—Captain F. Tymms, M.C., A.F.R.Ae.S., "Civil Aviation Prospects in East Africa."

May 23rd.—Mr. F. A. Foord, A.F.R.Ae.S., "Lubrication of Aircraft Engines."

July 20th.—Tord K. Angström, "Aeronautical Research in Sweden."

July 22nd.—Mons. P. Franck, "Recent Progress of Aeronautical Science in France."

July 24th.—Mr. H. E. Wimperis, C.B.E., M.A.,, F.R.Ae.S., "Aeronautical Progress in Great Britain."

July 25th.—R. Giacomelli, "An Historical Survey of Italian Aeronautics."

July 25th.—The Wilbur Wright Memorial Lecture by the Hon. Wm. P. MacCracken, Jun., Assistant Secretary of Commerce for Aeronautics and Member of the National Advisory Committee for Aeronautics of the U.S.A., on "Science in its Relation to Regulating and Promoting Civil Aviation." The lecture was delivered in the Science Museum, South Kensington, by kind permission of the Director, Colonel Sir Henry Lyons.

July 26th.—Dr. Ir. H. J. van der Maas, "The Development of Aviation and Recent Aeronautical Research in Holland in recent years."

October 10th.—Mr. C. R. Fairey, M.B.E., F.R.Ae.S., "The Range of Aircraft."

October 24th.—Captain N. MacMillan, M.C., A.F.C., A.F.R.Ae.S., A.M.I.Ae.E., "The Art of Flying Land and Sea Machines."
November 7th.—Dr. A. E. Dunstan, "Recent Developments of Fuels and Dopes for Aircraft Engines."
November 28th.—Squadron Leader H. M. Probyn, D.S.O., "Flying and Maintenance from the Owner's Point of View."
December 12th.—Dr. W. Rosenhain, D.Sc., F.R.S., "The Development of Materials for Aircraft Purposes."

The following lectures were delivered before the Students' section:—
January 25th.—Mr. T. Tanner on "Experimental Aerodynamics."
February 8th.—Mr. H. T. Edgecombe on "Flying."
February 22nd.—Mr. L. T. Brown on "The Napier Lion Engine."
March 8th.—Mr. E. N. B. Bentley on "The Case for Aircraft in Coast Defence."
October 29th.—Dr. N. A. V. Piercy on "Streamline and Turbulent Air Flow."
November 19th.—Mr. G. H. Stokes on "Engine Testing."
December 4th.—Mr. E. H. Lewitt on "Airship Design."
December 17th.—Mr. F. G. Evans on "The Method of Least Work and the Stressing of Aeroplane Structures."

The following is a list of the principal lectures held before the Branches:—
January 18th.—Before the Manchester Branch by Mr. Hackett on "Steel Tube Manipulation."
January 18th.—Before the Yeovil Branch, Mr. G. C. D. Russell on "The Automatic Slot."
January 23rd.—Before the Yeovil Branch, Flight Lieut. R. Linton Ragg, A.F.C., on "Experimental Flying."
January 24th.—Before the Halton Branch, Mr. F. Handley Page, C.B.E., F.R.Ae.S., on "Slotted Wings."
February 5th.—Before the Yeovil Branch, Mr. A. N. Caple on "Cirrus Mark III."
February 8th.—Before the Manchester Branch on "The Evolution of the Aeroplane."
February 15th.—Before the Yeovil Branch by Dr. E. G. Richardson on "Model Aerofoil Experiments."
February 18th.—Before the Halton Branch by Mr. L. Cullis and F./O. Latimer Needham on "H.A.C.3."
February 19th.—Before the Coventry Branch by Mr. H. B. Taylor on "Compression Ignition Engines."
February 20th.—Before the Yeovil Branch by Major J. L. Ledeboer.
February 26th.—Before the Leeds Branch by Mr. N. S. Norway on "Control of Rigid Airships."
February 28th.—Before the Bristol Branch, Captain F. S. Barnwell, O.B.E., A.F.C., F.R.Ae.S., on "Notes on the Aero Show held in Chicago, U.S.A., 1st-9th December, 1928."
March 4th.—Before the Halton Branch, Mr. H. J. Pollard, A.F.R.Ae.S., on "Metal Construction."
March 12th.—Before the Leeds Branch, Major F. A. Bumpus, F.R.Ae.S., on "The Development of Torpedo-Carrying Aircraft."
March 21st.—Before the Bristol Branch, Mr. C. F. Uwins on "Experimental Test Flying."
May 6th.—Before the Oxford Branch Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., on "Air Routes."
May 16th.—Before the Bristol Branch by Dr. E. G. Richardson, "Recent Model Experiments in Aerodynamics."

August 30th.—Before the Coventry Branch by Squadron Leader C. E. Kingsford Smith and Flight Lieutenant C. P. T. Ulm, on their trans-Pacific Australia-New Zealand-Australia and Australia-England flights.

October 17th.—Before the Bristol Branch, Mr. A. E. Russell, A.M.I.Ae.E., on "Load Factors."

October 25th.—Before the Yeovil Branch, the Hon. Lady Bailey on "Touring by Air."

October 30th.—Before the Halton Branch, lecture on the De Havilland Gipsy Engine.

November 1st.—Before the Yeovil Branch by J. W. Berry on "Cold Working of Metals."

November 4th.—Before the Oxford Branch by Professor M. Jones.

November 8th.—Before the Yeovil Branch by Mr. B. C. Hall on "Aero Brakes."

November 15th.—Before the Yeovil Branch by Squadron Leader D. C. M. Hume on "Aircraft in Canada."

November 18th.—Before the Oxford Branch by Squadron Leader Orlebar on "The Schneider Trophy Race and the Air Speed Record."

November 20th.—Before the Halton Branch by Captain Norman MacMillan, A.F.C., A.F.R.Ae.S., on "The Art of Flying Landplanes and Seaplanes."

November 21st.—Before the Bristol Branch by Mr. Frazer on "Wing Flutter."

November 22nd.—Before the Yeovil Branch, "Aero Wheels and Tyres."

November 28th.—Before the Halton Branch on "The Napier Lion Engine" by Mr. M. Tallyn.

December 5th.—Before the Yeovil Branch by Mr. R. B. Brigham, A.R.Ae.S.I., on "The Airship R.100."

Bristol Branch

A new branch of the Society was formed at Bristol, with Professor A. J. Sutton Pippard, D.Sc., M.Inst.C.E., F.R.Ae.S., as Chairman, and C. W. Tinson, Esq., F.R.Ae.S., as Hon. Secretary. The branch held their first meeting in the Merchant Venturers' College on February 28th.

Medals and Awards

At a meeting of Council held on December 11th, 1928, it was decided to adopt the following recommendation of the Medals and Awards Committee:—

> That the year for awarding all medals and prizes should be from July 1st to June 30th. In the case of the R.38 and Busk Memorial awards the dates for entry this year should be advanced from their present dates of September 30th and December 31st, 1928, to March 31st, 1929, and that the papers should be delivered to the Secretary by June 30th.

The Committee also recommended and the Council adopted the following resolution:—

> That the Wilbur Wright Memorial Lecture should not be included in the lectures to be considered for the awards of any medals and prizes by the Society.

At a Council Meeting held on November 19th, 1929, it was decided to adopt the following recommendation of the Medals and Awards Committee:—That as from July 1st, 1929, the Council should be free to consider any paper eligible for any award, whether specifically entered for that award or not, and that the present rules should be amended accordingly.

The following awards were made for 1927-1928:—

The Taylor Gold Medal to Mr. R. K. Pierson, B.Sc., Assoc.M.Inst.C.E., F.R.Ae.S., for his paper on "The Use of the Wind Tunnel for Performance Prediction." The paper was published in the JOURNAL for February, 1928.

The Simms Gold Medal to Captain F. Entwistle for his paper on "Fog." The paper was published in the JOURNAL for May, 1928.

The Sir Charles Wakefield Gold Medal to Mr. Handley Page, C.B.E., F.R.Ae.S., for his work in connection with the Automatic Slot.

The Silver Medal of the Society to Mr. B. N. Wallis for his work in connection with R.100.

The following awards were made for the year 1928-29:—

Sir Charles Wakefield Gold Medal to Mr. H. B. Irving, F.R.Ae.S., for his work in connection with slot and control.

Taylor Gold Medal to Professor B. Melvill Jones, A.F.C., M.A., F.R.Ae.S., for his paper on "The Streamline Aeroplane," delivered before the Society on January 10th, 1929.

Simms Gold Medal to Mr. H. Sutton, M.Sc., A.F.R.Ae.S., for his paper on "The Use of Light Alloys in Aircraft from the Point of View of Corrosion," delivered before the Society on October 18th, 1928.

Busk Memorial Prize to Mr. W. S. Farren, M.B.E., M.A., F.R.Ae.S., M.I.Ae.E., for his paper "Monoplane or Biplane?" delivered before the Society on January 21st, 1929.

ELLIOTT MEMORIAL PRIZE

The subject for the Elliott Memorial Prize Essay for 1929 was decided upon, by the Council, as follows:—

"The contribution of Mechanical Skill to the work of the Royal Air Force."

The prize was divided between Apprentices Armstrong and Lanham.

INTERNATIONAL AERO SHOW, OLYMPIA, JULY 16TH—27TH, 1929

The Royal Aeronautical Society was represented at the International Aero Show at Olympia, July 16th-27th, by a remarkable historical exhibit showing the gradual evolution of the idea and practice of flight in Great Britain from the earliest down to recent times. A full account of the exhibit was given in a special Souvenir Booklet published during the Exhibition and in the October number of the JOURNAL.

During the Exhibition a series of Lectures on the progress of Aeronautics in Great Britain and other countries was given. These lectures were printed in full in the October JOURNAL. A series of technical and non-technical aviation films were also shown, 6,381 people attending.

The Society also made arrangements for parties of school children to visit Olympia on certain days and to be shown round the Exhibition. Over 3,600 children visited the Exhibition under the ægis of the Society.

INFORMAL DISCUSSIONS AND DINNERS

On Thursday, January 24th, 1929, an Informal Discussion and Dinner were held at the St. Ermin's Hotel, Caxton Street, Westminster, S.W.1. The subject for discussion was "The Compression Ignition Engine." The case for the Compression Ignition Engine was stated by Wing Commander G. B. Hynes, D.S.O., and the case for the Petrol Engine by Captain G. S. Wilkinson, A.F.R.Ae.S., of Messrs. Napiers. The chair was taken by the President, Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S.

On Friday, November 15th, 1929, an Informal Discussion and Dinner were held at the St. Ermin's Hotel. After the dinner Major J. S. Buchanan moved the following resolution:—"That this meeting is of the opinion the present rules for the Schneider Trophy Race and the High Speed Record are not consistent with the proper development of high speed aircraft." The chair was taken by the President, Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., and after an interesting discussion the motion was put to the vote and lost.

At both the above meetings over a hundred members were present.

Visit to Cardington

On Saturday, May 25th, a visit was paid to the Royal Airship Works at Cardington to see H.M. Airship R101. The visit was attended by some three hundred members and friends, and proved to be one of the most interesting and enjoyable ever arranged by the Society. It was not found practicable to allow more than one hundred members over the ship itself, but all were admitted to the works and were able to see the ship from the ground.

The Council wish to place on record their grateful thanks to those at the Royal Airship Works who did so much to make the visit so successful, and particularly to Group-Captain F. M. Fellows, D.S.O., Director of Airship Development, Lieut.-Col. V. C. Richmond, O.B.E., Wing-Commander T. R. Cave-Browne-Cave, C.B.E., who had general charge of the arrangements, and to the following, who acted as volunteer guides:—Squadron-Leader F. M. Rope, Flying Officer Fitzgerald, Flying Officer Cock, Mr. Collins, Mr. McWade, Mr. Dyer, Mr. Pugsley, Mr. Rayner, Mr. Eldridge, Mr. Randle, Mr. Uren, Mr. Hayes, Mr. Brook, Mr. Hogg, Mr. Harris, Mr. Taylor, Mr. Thompson, and Mr. Weston. The members and guests were received by the President, Colonel the Master of Sempill, assisted by the Hon. Mrs. Forbes Sempill.

Donations to Society's Funds

The Council wish to acknowledge the magnificent donation of $10,000 from the Daniel Guggenheim Fund for the Promotion of Aeronautics. The following cables have been received and sent:—

"Have pleasure informing you Guggenheim Fund has awarded final grant of ten thousand dollars to enable Society continue for further two years the work previously supported by fund. Please cable acknowledgment.—Mayo, Guggenheim Fund, New York."

"Harry Guggenheim. Council and all members deeply touched by your continued interest and confidence in the Society's ability to further the cause of aeronautics so greatly aided throughout the world by the Daniel Guggenheim Fund. But for the generous support received from the fund in the past our activities would have been considerably restricted. The munificent donation just received will enable us to continue these activities and lead to the Society attaining a position of greater strength and independence.—Sempill, *President*."

For the fifth year in succession the Society of British Aircraft Constructors have granted a sum of £250 to further the objects of the Society. The generous support of the Society of British Aircraft Constructors has enabled the Council to proceed with schemes which would otherwise have been held in abeyance, and the Council wish to place on record their great gratification at the attitude of the trade body towards the Society.

The Necessity for Municipal Air Ports

A Conference on the Necessity for Municipal Air Ports was held in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, Victoria

Embankment, on Tuesday, 5th November, under the auspices of the Royal Aeronautical Society, the Royal Aero Club, and the Air League of the British Empire.

The Conference was called after consultation with the Air Ministry (through Sir Sefton Brancker, Director of Civil Aviation), the Royal Aero Club and the Air League of the British Empire, following the air tour of Sir Alan Cobham in 1929. The Conference was addressed on questions relating to the construction, organisation and operation of municipal air ports, by Mr. Montague, Under Secretary of State for Air, Lord Herbert Scott, President of the London Chamber of Commerce, the Master of Sempill, Sir Alan Cobham, Major Mealing and Major L. F. Richard. The chair was taken by the President of the Royal Aeronautical Society, Colonel the Master of Sempill.

Assistant Secretary

Miss Olive St. Barbe St. Barbe relinquished her position as Assistant Secretary in August. Miss St. Barbe joined the Society in 1917 and served during years of great difficulty, when her knowledge and ability proved to be of the greatest possible assistance. At the Council Meeting, held on September 4th, a special honorarium was voted to Miss St. Barbe as a token of the Society's appreciation of her services during the past twelve years.

Technical Index

For the past two years the Secretary has been laying the foundation of a Technical Index which, it is hoped, will be of some value to members of the Society.

The main object of this card index is to provide references to technical articles, official reports, papers, lectures, etc., on all aspects of aviation and its allied sciences. A very wide field has been covered, and though the index does not pretend to be exhaustive, it is very comprehensive. Among sources of information which have been indexed may be mentioned:—

(*a*) The leading aeronautical papers in Great Britain, Germany, France, Italy, America.

(*b*) Official reports, including R. & M.'s, N.A.C.A. Reports and Technical Notes, Göttingen, Koutchino Laboratory, Amsterdam Institute, Aeronautical Institute of Tokyo, Italian Aeronautical Institute, Brussels Aeronautical Institute, and Canadian Air Board Reports.

(*c*) Library of Royal Aeronautical Society, Library of Congress, Washington Public Library.

(*d*) Scientific journals.

(*e*) Abstracts prepared by various bodies and institutions.

The index contains approximately some 20,000 entries and is being continually added to. The cards are arranged under subject headings and copiously cross-referenced.

It is hoped that members of the Society will make free use of this technical index and get into the habit of looking upon the Society as the headquarters from which references to aeronautical information can be readily obtained. It should be understood that, as a general rule, references only to any particular subject can be given, as the work involved in sending the actual information would mean employing a very much larger staff than the Society at present can afford.

Gifts of Lantern Slides

The Council acknowledge with gratitude the receipt of the following slides from the Gloster Aircraft Company :—

Gloster IV.
Gloster Goring on Floats.
Gloster Goldfinch.
Gloster Gamecock II.
Gloster Gambet.
Gloster Grebe for New Zealand.

and seventeen lantern slides illustrating the Automatic Slot and Interceptor Control from Messrs. Handley Page, Ltd.

Photographs

During the year the large collection of photographs which the Society possesses has been classified and is in the process of being indexed. The majority of the work has been done by Mr. Howard Flanders, who has placed his wide knowledge of early machines and engines at the disposal of the Society. The work of arranging these photographs and identifying them has been difficult, and the Council wish to place on record their grateful thanks to Mr. Howard Flanders for the great amount of time he has given to the work.

In the process of classification it was found that there were numerous gaps in the Society's collection. An appeal was made to members and to various firms in the industry, and it met with an immediate and generous response, with the result that many gaps were filled. The Society now possesses one of the biggest collections of photographs of aeroplanes and engines in existence.

It has been found difficult to obtain photographs of many early machines and engines, and of airships, and the Council hope that any member who has spare copies of such photographs will present them to the Society.

The Council wish to acknowledge the very generous help which the following have already given towards making the collection complete :—

A gift of 150 negatives from Mr. W. O. Manning of aeroplanes, etc., taken between 1909 and 1914, and an album of newspaper photographs of flying in 1908-1909, containing a rare set of contemporary French postcards of famous pilots and their machines. Many of the photographs in Mr. Manning's collection are unique and have enabled the Society to fill up frequent gaps in their file of historical photographs.

From Mr. Oswald Short, of Messrs. Short Brothers, of an album of 30 photographs and copy negatives of old machines. These photographs include some of Sir Hiram Maxim's machine and early days of flying at Eastchurch and Brooklands.

Photographs of H.M.A. " Beta " from M. Downer, and autographed photographs of Sir John Alcock and Sir Arthur Whitten Brown and Sir Ross Smith and Sir Keith Smith, with their Vickers-Vimy Rolls aeroplanes from Mrs. O'Brien, widow of the late H. S. O'Brien.

Photographs from Messrs. the Hawker Engineering Company, of their aeroplanes, from Messrs. Napiers of the Napier Engines and from the Monospan Wing Company of the Stieger Wing.

Donations to the Library

The Council gratefully acknowledge a gift of the following books to the Library by Wing Comdr. Hubbard :—

" Gnome " Mono. Instruction Book No. 2.
Air Publication 129. Flying Training Manual. Part I., Flying Instruction. 1920.

Les Moteurs Gnome. Description Conduite Entretien. 1911.
Royal Air Force Flying Training. Part II., Applied Flying. December, 1922. Air Publication 928.
Handbook of the Renault Engine. 1913.
The Gnome Engine. Its Care, Maintenance and Use. By Major J. D. B. Fulton. 1913.

The Council wish also to acknowledge the gift of a number of JOURNALS by Mr. Griffith Brewer. Many of these JOURNALS are out of print, and Mr. Brewer's gift has enabled the Society to fill in a large number of gaps. The Council will always welcome gifts of old JOURNALS for this reason, as many years are now incomplete.

The Council have also to acknowledge their appreciation of a gift of albums of old newspaper cuttings of airships and balloons from E. Townsend, Esq., and of three bound volumes of the catalogues issued by the London Aerodrome at Hendon for the years 1912-14 from W. S. Robson, Esq.

LIBRARY ADDITIONS, NOVEMBER 1928—NOVEMBER 1929

AERONAUTICAL RESEARCH COMMITTEE.

Technical Reports for 1926-1927, 1927-1928, 1928-1929.

R. & M. No. 1154. Wind Tunnel Experiments on a Model Autogyro at Small Angles of Incidence. C. N. H. Lock and H. C. H. Townend.
R. & M. No. 1165. Wind Tunnel Experiments on the Design of an Automatic Slot for R.A.F. 28 Section. F. B. Bradfield and K. W. Clark.
R. & M. No. 1166. The Force Acting on a Body Placed in a Curved and Converging Stream of Fluid. G. I. Taylor.
R. & M. No. 1167. Photographs of Streamers illustrating the Flow Around an Airscrew in the Vortex Ring State. C. H. N. Lock.
R. & M. No. 1168. Experiments on a Model of the Airship R.101. R. Jones and A. H. Bell.
R. & M. No. 1169. The Distribution of Pressure over the Hull and Fins of a Model of the Rigid Airship R.101. R. Jones and A. H. Bell.
R. & M. No. 1170. Report of the Airworthiness of Semi-Rigid Airships Sub-Committee.
R. &. M. No. 1171. The Theoretical Relationships for an Aerofoil with a Multiply Hinged Flap System. W. G. S. Perring.
R. & M. No. 1172. The Effects of Wing, Weight and Atmospheric Conditions on the Distance Take-off B. H. Rolls and H. L. Stevens.
R. & M. No. 1173. Full-Scale Determination of the Effect of High Tip Speeds on the Performance of an Airscrew. W. G. Jennings.
R. & M. No. 1174. Wind Tunnel Tests with High Tip Speed Airscrews—Some Experiments. G. P. Douglas and W. G. A. Perring.
R. & M. No. 1175. An Analysis of a Rectangular Monoplane with Hinged Tips.
R. & M. No. 1176. The Boundary Layer of the Front Portion of a Cylinder. A. Thom.
R. & M. No. 1177. A Brief Survey of Wing Flutter. R. A. Frazer and W. J. Duncan.
R. & M. No. 1178. The Change in Airscrew Characteristics with Height. D. S. Research.
R. & M. No. 1179. Airflow around a Circular Cylinder in the Region where the Boundary Layer Separates from the Surface. A. Fage.
R. & M. No. 1180. The Inclusion of Partial Glides in Routine Performance Tests. A. E. Woodward Nutt.
R. & M. No. 1181. Instrumental Records of the Lateral Motions of a Stalled Bristol Fighter Aeroplane. B. Melvill Jones and C. E. Maitland.

R. & M. No. 1182. Rolling Experiments on an Aerofoil of R.A.F. 32 Section. H. B. Irving.

R. & M. No. 1183. The Behaviour of a Single Crystal of Zinc subjected to Alternating Torsional Stresses. H. J. Gough and H. L. Cox.

R. & M. No. 1184. Experiments on a Model of a Single-Seater Aeroplane in Connection with Spinning. H. B. Irving.

R. & M. No. 1185. The Strength of Tubular Struts. Prof. A. Robertson.

R. & M. No. 1186. Wind Tunnel Tests of Various Servo Rudder Systems. K. V. Wright.

R. & M. No. 1187. On the Use of a Follow-up Mechanism in Aerodynamic Servo Control System. H. M. Garner and K. V. Wright.

R. & M. No. 1188. Full-Scale Experiments with a Bristol Fighter fitted with Slots and Flaps and Slot and Aileron Control. K. V. Wright.

R. & M. No. 1189. Notes on Longitudinal Stability at Stalling in Gliding Flight. S. B. Gates.

R. & M. No. 1190. Wind Tunnel Experiments on the Design of an Automatic Slot for R.A.F. 31 Section. F. B. Bradfield and F. W. G. Greener.

R. & M. No. 1191. Full-Scale Tests of a Standard Bristol Fighter Aeroplane fitted with " Pilot Planes " at the Wing Tips. W. G. Jennings.

R. & M. No. 1192. Wind Tunnel Tests for Design of an Automatic Slot for Avro 504 N. E. T. Jones and K. W. Clark.

R. & M. No. 1193. Longitudinal Control of an Aeroplane beyond the Stall. H. M. Garner and K. V. Wright.

R. & M. No. 1194. An Investigation of Fluid Flow in Two Dimensions. A. Thom.

R. & M. No. 1195. Mechanical Method for Solving Problems of Flow in Compressible Fluids. G. I. Taylor and C. F. Sharman.

R. & M. No. 1196. Report on the Progress during 1927-28 in Calculation of Flow of Compressible Fluid, and Suggestions for Further Work. G. I. Taylor.

R. & M. No. 1197. Wing Flutter Experiments on a Model of a Seater Biplane. W. G. A. Perring.

R. & M. No. 1198. Wind Tunnel Tests with High Tip Speed Airscrews. The Characteristics of a Conventional Airscrew Section 0.082c. Thick. H. M. Garner, K. V. Wright, G. P. Douglas and W. G. A. Perring.

R. & M. No. 1201. On the Stiffness of Crankshafts. H. Constant.

R. & M. No. 1202. Determination of the Twist of a Wing of an Aeroplane in Flight. W. G. Jennings.

R. & M. No. 1204. Wind Tunnel Experiments on the Design of an Auto-Slot for R.A.F. 34 Section. F. B. Bradfield and F. W. G. Greener.

R. & M. No. 1205. Full-Scale Tests of Bristol Fighter Aeroplane with R.A.F. 30 Wings, fitted with " Pilot Planes " at the Wing Tips. W. G. Jennings.

R. & M. No. 1206. Wind Tunnel Experiments with Infinite Cascades of Aerofoils. R. G. Harrison and R. A. Fairthorne.

R. & M. No. 1208. A Dash-Pot for Use in Spinning Experiments on a Model Aerofoil. T. H. Fewster.

R. & M. No. 1209. A Direct Method of Discriminating between Steady and Turbulent Air Flow over the Wing Surfaces of Aircraft in Flight; Applied to Explore the Region of Effect of the Slot on a Bristol Fighter Wing. J. A. G. Haslem.

R. & M. No. 1210. On the Effect of Air Compression on Drag and Pressure Distribution in Cylinders of Infinite Aspect Ratio. T. E. Stanton.

R. & M. No. 1211. The Effective Torsional Rigidity of a Crank.

R. & M. No. 1212. Preliminary Tests on the Effect on the Lift of a Wing of the Position of the Airscrews Relative to it. F. B. Bradfield.

R. & M. No. 1213. Wind Tunnel Tests of Aerofoils with Pilot Planes. F. B. Bradfield.

R. & M. No. 1214. On the Method of Delaying the Opening of an Autoslot (Wind Tunnel Experiments). F. B. Bradfield and R. A. Fairthorne.

R. & M. No. 1215. The Accelerated Motion of a Cylindrical Body through a Fluid. H. Glauert.

R. & M. No. 1216. The Lift and Pitching Moment of an Aerofoil due to a Uniform Angular Velocity of Pitch. H. Glauert.

R. & M. No. 1218. Hydrodynamic Forces on a Cylinder Moving in Two Dimensions. H. Lamb.

R. & M. No. 1219. Investigation into the Proposed Use of a Sand Cast Test Bar for Specification Purposes for Aluminium Alloys. W. Rosenhain and S. L. Archbutt.

R. & M. No. 1221. The Effect of Stress upon the X-Ray Reflections from Tungsten Wire at Air Temperature. H. L. Cox.

R. & M. No. 1223. On the Two-Dimensional Flow Past a Body of Symmetrical Cross Section Mounted in a Channel of Infinite Breadth. A. Fage.

R. & M. No. 1225. Wind Tunnel Tests of a R.A.F. 30 Wing fitted with a Self-Setting Slotted Wing " Pilot Plane." F. B. Bradfield.

R. & M. No. 1226. The Characteristics of a Tapered and Twisted Wing with a Sweep Back. H. Glauert and S. B. Gates.

R. & M. No. 1231. The Skin Friction on a Circular Cylinder. A. Fage.

R. & M. No. 1232. On the Maximum Load in Pulling Out from Vertical Dives. S. B. Gates and H. B Howard.

R. & M. No. 1236. The Control of the Fokker F.VII-3M Aeroplane.

R. & M. No. 1240. Rolling and Sideslip on a Model Slotted Biplane of R.A.F. 31 Section. H. B. Irving and A. S. Baton.

R. & M. No. 1246. Measurement of Landing Loads. E. T. Jones.

R. & M. No. 1249. Measurement of Lateral Derivatives on the Whirling Arm. L. W. Bryant and A. S. Hailiday.

R. & M. No. 1253. Report on Some Properties of Alloys of Aluminium with Thorium and Silicon. J. D. Grogan and T. H. Schofield.

R. & M. No. 1257. Comparison of Calculated and Measured Elasticity of the Wings of an Aircraft, in connection with the Investigation of Wing Flutter. K. T. Spencer and D. Seed.

R. & M. No. 1260. Flight Tests on an Atlas fitted with Automatic Slots connected with the Ailerons and some Data Relevant to the Design of Auto-Slots for R.A.F. 28 Section Wing. E. T. Jones.

R. & M. No. 1261. Experiments on the Spinning of a Bristol Fighter Aeroplane. K. V. Wright.

R. & M. No. 1262. The Application of the Servo Principle to Aileron Operation. A. S. Hartshorn.

Air Publication 1208. Amendment to Airworthiness. Handbook for Civil Aircraft.

Air Publication 1342. Lion Aero Engine (Series XIa).

Air Publication 1346. Supercharger Unit as fitted to the Jaguar IV Engine.

Air Publication 1375. The Armstrong-Whitworth Atlas Army Co-operation Aeroplane.

Handbook of the Renault Engine. 1913.

The Air Pilot. Vol. I.

Report on the Progress of Civil Aviation. 1928.

Airworthiness Handbook for Civil Aircraft. June, 1929.

Professional Papers of the Air Survey Committee No. 5. Calibrating of Surveying Cameras. Capt. M. Hotine.

Royal Flying Corps Training Manual. 1914.

Royal Flying Corps Training Manual. 1915.
Royal Air Force Training Manual. 1920.
Royal Air Force Training Manual. 1922.
This Bondage. B. Acworth.
Air Defence. Major-General E. B. Ashmore.
French Dictionary. Bellows.
Le Wimereux-Plage. C. Bigeault.
Weather and the Airplane. E. H. Bowie.
Air Annual of the British Empire. Edited by Squadron Leader C. G. Burge.
The Airplane and its Engine. C. H. Chatfield and C. F. Taylor.
Mechanics of Internal Work or Works of Deformation in Elastic Bodies and Systems in Equilibrium. I. P. Church.
The Treatise on Engine Balance, using Expotentials. Cormac.
Wessex from the Air. A. G. S. Crawford and A. Keiller.
Alkaline Accumulators. J. T. Crennell and F. M. Lea.
The Institution of Naval Architects and its Work. R. W. Dana.
Airmen's International Dictionary. M. M. Dander.
How to Fly. Richard Ferris.
The Gnome Engine. J. D. B. Fulton.
The Story of a North Sea Air Station. C. F. Snowden Gamble.
Jane's All the World's Aircraft. C. G. Grey and L. Bridgman.
International Aircraft Markings. E. Grosvenor and L. Bridgman.
The Properties and Applications of Invar and Related Alloys. A. Guillaume.
One Man's War. Bert Hall and John J. Niles.
International Airports. S. S. Hanks.
Aerial Locomotion. E. H. Harper and A. Ferguson.
The Application of Science to the Steel Industry. W. H. Hatfield.
The First English Aeronaut; James Sadler, of Oxford (1753-1828). J. E. Hodgson. (Reprinted from *Cornhill.*)
Aircraft Stress Analysis. A. Klemin.
The Zeppelins. E. Lehmann and H. Mingos.
The Art of Flying. Capt. N. MacMillan.
Into the Blue. Capt. N. MacMillan.
Applied Aerial Photography. A. C. McKinley.
Flying Machines—Past, Present and Future. A. W. Marshall and H. Greenly.
Simple Aerodynamics and the Airplane. C. N. Monteith.
The Strength of Shafts in Vibration. J. Morris.
Fundamentals of Fluid Dynamics for Aircraft Designers. Max. M. Munk.
The Great Delusion. "Neon."
Airplane Structures. A. S. Niles and J. S. Newell.
The A.B.C. of Aviation. V. W. Page.
Modern Aviation Engines. V. W. Page. Vols. I and II.
Strain Energy Methods of Stress Analysis. A. J. Sutton Pippard.
The Book of the Aeroplane. (2nd Edition.) J. L. Pritchard.
Aircraft Float Design. H. C. Richardson.
The Third Route. Sir P. Sassoon.
About the Subjective Appearance of the Horizon Line and Earth Surface during Flights at High Altitudes; a Contribution to the Myosenoric Function of the Eye-Muscle. G. Schubert.
Nineteenth Century. Edited by Wray Skilbeck.
The Great Trans-Pacific Flight. The Story of the Southern Cross. C. E. Kingsford Smith and C. T. P. Ulm.
Pseudo-Security. J. M. Spaight.
Practical Flight Training. B. Studley.
Learning to Fly. F. A. Swoffer.

Aeroplanes, Seaplanes and Aero Engines. C. F. Taylor and C. H. Chatfield.
Fighting Corrosion. T. H. Turner.
Dictionary of Aeronautical Terms. J. Vanier.
Aerial Navigation and Meteorology. L. A. Yancey.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Extract from Proceedings of the Royal Society, Vol. CXXIII, 1929. The Forces on a Solid Body Moving through Viscous Fluid. The Steady Flow of Viscous Fluid Past a fixed Spherical Obstacle at small Reynolds' Numbers. S. Goldstein.

Economic Proceedings of the Royal Dublin Society. Vol. II, No. 25, June, 1929.

Scientific Proceedings of the Royal Dublin Society. Vol. XIX, N.S., Nos. 9-13, Nov., 1928; Vol. XIX, N.S., Nos. 14-18, Mar., 1929; Vol. XIX, N.S., Nos. 19, April, 1929; Vol. XIX, N.S., Nos. 20-28, Sept., 1929.

Proceedings of the Royal Society of Edinburgh. Vol. XLVIII, Part III; Vol. XLIX, Part I.

Journal and Proceedings of the Royal Society of New South Wales for 1928.

Institution of Engineers and Shipbuilders in Scotland. R. D. Moore.

Aeronautics Handbook of the Collections illustrating Heavier-than-Aircraft. Science Museum.

Transactions of the A.S.M.E. Aeronautics. Jan.-April, 1928; May-Aug., 1928; Sept.-Dec., 1928; Jan.-Mar., 1929.

Aluminium Bronze. British Aluminium Co.

Aluminium Sections and Matting. British Aluminium Co.

Aluminium Sheet Metal Work, No. 296. British Aluminium Co.

British Engineering Standards Association. British Standard Specifications for Aircraft Materials and Components. [4 K.6 October, 1928] Cast Iron Piston Ring Pots. [3 S.1 July, 1928] (cancelling B.S. Specification 2 S.i.—Pt. 1 and S.35) Bright Steel Bars.

Committee of British Science Guild. Report on the Reform of the British Patent System.

15th Annual Report of the Carnegie United Kingdom Trust.

The Central Library for Students. 13th Annual Report, 1928-1929.

F.B.I. Register of British Manufacturers, 1929-1930.

Third Report of the Gas Cylinders Res. Committee.

Care of the 100 h.p. Gnome Monosoupape Engine. Gnome Engine Co.

Industrial Arts Index, 1928.

The Mechanical Properties of some Nickel Steels. Bur. of Information on Nickel. Mond Nickel Co.

Typical Applications of Nickel and Nickel-Chromium Cast Iron. Bureau of Information on Nickel. Mond Nickel Co.

National Physical Laboratory Report for the year 1928.

Official Catalogue of the 7th International Aero Exhibition, Olympia, London, 1929.

Official Exhibition of the French Air Ministry in London. 7th International Aero Exhibition, Olympia, London, 1929.

Proceedings of the Inst. of Automobile Engineers. Session 1928-1929, No. 23.

World Engineering Congress, Tokyo, Oct.-Nov., 1929. Second Announcement.

Journal of Commerce Annual Review, 1924.

Journal of the Institution of Electrical Engineers. Dec., 1928—Nov., 1929.

Journal of the Junior Institution of Engineers, 1928.

Journal of the Institute of Metals. No. 2, 1928, Vol. XL.

Journal of the Institute of Metals. No. 1, 1929, Vol. XLI.

Smithsonian Reprints:—Isaac Newton, A. Einstein. Soaring Flight, W. Klemperer. Geological Climates, W. B. Scott. At the North Pole, L. Ellsworth.

Department of Scientific and Industrial Research, Dominion of New Zealand. Observations of Upper Air Currents at Apia, W. Samoa. Andrew Thomson.

METEOROLOGY.

Met. Office. Geophysical Memoirs, No. 43, Vol. V. The Regular Diurnal Variation of Magnetic Declination at Kew Observatory. C. Chree.

Met. Office. Geophysical Memoirs, No. 44, Vol. V. The Distribution of Mean Annual Maximum and Minimum of Temperature over the Globe. C. E. P. Brooks and G. L. Thorman.

Met. Office. Geophysical Memoirs, No. 45. Measurements of the Effective Electrical Conductivity of the Air and the Earth's Electric Field. R. E. Watson.

Met. Office. Geophysical Memoirs, No. 46. A Study of the Vertical Gradient of Temperature in the Atmosphere near the Ground. N. K. Johnson.

Met. Office. Geophysical Memoirs, No. 47. Report on Thames Flood. A. T. Doodson.

Memoirs of the Royal Met. Society, Vol. III, No. 23. Distribution of Terrestrial Radiation. G. C. Simpson.

Bibliography of Meteorological Literature. Vol. II, No. 15.

Met. Office. Report of the Seventh Meeting, May, 1928.

Met. Office. The Book of Normals. Section VI. Normals of the Relative Humidity.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

Fourteenth Annual Report.

Report No. 289. Forces on Elliptic Cylinders in Uniform Air Stream. A. F. Zahm, R. H. Smith and F. A. Louden.

Report No. 292. Characteristics of Five Propellers in Flight. J. W. Crowley, Jun., and R. E. Mixson.

Report No. 293. Two Practical Methods for Calculation of Horizontal Tail Area Necessary for Statically Stable Airplane. W. S. Diehl.

Report No. 294. Measurement of Maximum Cylinder Pressures. C. W. Hicks.

Report No. 295. The Variation in Engine Power from Measurements in Flight with a Hub Dynamometer. W. D. Gove.

Report No. 296. Pressure Distribution Tests on PW-9 Wing Models from $-18°$ through $90°$ Angle of Attack. O. E. Loeser.

Report No. 297. Reduction of Observed Airplane Performance to Standard Conditions. W. S. Diehl.

Report No. 298. Effect of Variation of Chord and Span of Ailerons on Rolling and Yawing Moments in Level Flight. R. H. Heald and D. H. Strother.

Report No. 299. Investigation of Damping Liquids for Aircraft Instruments. G. H. Keulegan.

Report No. 300. The Twenty-Foot Propeller Research Tunnel of the N.A.C.A. F. E. Weick and D. H. Wood.

Report No. 301. Full-Scale Tests of Wood Propellers on a VE-7 Airplane in the Propeller Research Tunnel. F. E. Weick.

Report No. 302. Full-Scale Tests on a Thin Metal Propeller at Various Tip Speeds. F. E. Weick.

Report No. 303. An Investigation of the Use of Discharge Valves and an Intake Control for Improving the Performance of N.A.C.A. Roots' Type Supercharger. O. W. Schey and E. E. Wilson.

Report No. 304. Investigation of the Aerodynamic Characteristics of an Airplane equipped with several Different Sets of Wings. J. W. Crowley and M. W. Green.

Report No. 305. Gaseous Explosive Reaction. F. W. Stevens.

Report No. 306. Full-Scale Wind Tunnel Tests of a Series of Metal Propellers on a VE-7 Airplane. F. E. Weick.

Report No. 307. Pressure Distribution over the Horizontal and Vertical Tail Surface of the F6C-4 Pursuit Airplane in Violent Manœuvres. R. V. Rhode.

Report No. 308. Aircraft Accidents.

Report 309. Joint Report of Standardisation Tests on N.P.L. R.A.F. 15 Airfoil Model. W. S. Diehl.

Report No. 310. Pressure Element of Constant Logarithmic Stiffness for Temperature Compensated Altimeter. W. G. Brombacher and F. Cordero.

Report No. 312. The Prediction of Airfoil Characteristics. G. J. Higgins.

Report No. 314. Drag and Cooling with Various Forms of Cowling for a Whirlwind Radial Air-Cooled Engine. F. E. Weick.

Report No. 315. Aerodynamics Characteristics of Airfoils—VI.

Report No. 316. Tables for Pressure of Air on Coming to Rest from Various Speeds. A. F. Zahm and F. A. Louden.

Report T.N. No. 317. Tests of Four-Type Airfoils in the Twenty-Foot Propeller Research Tunnel. F. E. Weick.

Report No. 321. Fuel Vapour Pressures and the Relation of Vapour Pressure to the Preparation of Fuel for Combustion in Fuel Injection Engines. W. F. Joachim and A. M. Rothrock.

Report No. 322. An Investigation of Air Flow in Open-Throat Wind Tunnels. E. N. Jacobs.

Technical Note No. 294. Wind Tunnel Force Tests in Wing Systems through Large Angles of Attack. C. J. Wenzinger and T. A. Harris.

Technical Note No. 295. The Effect of Tip Shields on a Horizontal Tail Surface. P. V. Dronin, E. L. Ramsden and G. J. Higgins.

Technical Note No. 296. Bearing Strength of Wood under Steel Aircraft Bolts and Washers and other Factors Influencing Fitting Design. G. W. Trayer.

Technical Note No. 297. Preliminary Report on the Flat Top Lift Curve as a Factor in Control at Low Speed. M. Knight and M. J. Bamber.

Technical Note No. 298. The Determination of Several Spray Character of a High Speed Oil Engine Interjection System with an Oscillation. Hicks and Moore

Technical Note No. 299. The Effects of Fillets between Wings and Fuselages on the Drag and Propulsive Efficiency of an Aeroplane. M. N. Gough.

Technical Note No. 300. The Variation in Pressures in the Cockpit of an Airplane in Flight. T. Carroll and W. McAvoy.

Technical Note No. 301. Drag and Cooling with Various Forms of Cowling for a " Whirlwind " Engine in a Cabin Fuselage. F. E. Weick.

Technical Note No. 302. A New Method for the Prediction of Airplane Performance. E. P. Lesley and E. G. Reid.

Technical Note No. 303. Condensed Data on the Aircraft Engines of the World. C. S. Fliedner.

Technical Note No. 304. Corrosion Embrittlement of Duralumin *v.* Results of Weather Exposure Tests. H. S. Rawdon.

Technical Note No. 305. Corrosion Embrittlement of Duralumin VI. The Effect of Corrosion, accompanied by Stress on the Tensile Properties of Sheet Duralumin. H. S. Rawdon.

Technical Note No. 306. Curves showing Column Strength of Steel and Duralumin Tubing. O. E. Ross.

Technical Note No. 307. Strength of Tubing under Combined Axial and Transverse Loading. L. B. Tuckerman, S. N. Petrenko and C. D. Johnson.

Technical Note No. 308. Pressure Distribution on a Slotted R.A.F. 31 Airfoil in the Variable Density Wind Tunnel. E. N. Jacobs.

Technical Note No. 309. Correcting Engine Tests for Humidity. D. S. Brooks.

Technical Note No. 310. Wind Tunnel Pressure Distribution Tests on a Series of Biplane Wing Models. Part I. M. Knight and R. W. Noyes.

Technical Note No. 311. The Use of Wheel Brakes on Airplanes. T. Carroll and S. J. De France.

Technical Note No. 312. Sphere Drag Tests in the Variable Density Wind Tunnel. E. N. Jacobs.

Technical Note No. 313. The Formation of Ice upon Airplanes in Flight. T. Carroll and W. H. McAvoy.

Technical Note No. 314. Spiral Tendency in Blind Flying. T. Carroll and W. H. McAvoy.

Technical Note No. 315. Viscosity of Diesel Engine Fuel Oil under Pressure. M. D. Hersey.

Carnegie U.K. Trust. Fifteenth Annual Report.

Second Report of the Daniel Guggenheim Fund for the Promotion of Aeronautics.

Report of Civil Aviation, 1928. Department of National Defence, Dominion of Canada.

International Civil Aeronautics Conference, Washington, 1928.

Civil Aeronautics. Revision of 1923 Edition of Law Memoranda upon Civil Aeronautics. Office of the Legislative Counsel, Washington.

REPORTS OF THE AERONAUTICAL RESEARCH INSTITUTE, TOKYO.

No. 42. On the Acoustical Properties of Conical Horns. R. Sato-Kozi.

No. 43. The Theory and Design of a New Carburettor. M. Isikawa.

No. 44 On the Interference of Wind Tunnel Walls of Rectangular Cross-Section. K. Terazawa.

No. 45. Some Problems of Shocks transmitted in Bars and in Plates. K. Sexawa.

No. 46. On the Effect of the Wall of a Wind upon the Lift Coefficient of a Model. S. Tatudiro.

No. 47. Directional Observations of the Radio-Atmospheric Disturbances. Y. Munetomo and Y. Yosida.

Bulletin of the Institute of Phys. and Chem. Res. Vol. VIII, Nos. 3-7. Vol. VII, No. 2.

The Bulletin of the Inst. of Phys. and Chem. Res. Vol. VIII, No. 10.

Abstracts from the Bull. of Inst. of Phy. and Chem. Res. Vol. VIII, Nos. 1-10

Extracts from the Inst. of Phys. and Chem. Res., Tokyo University. Vol. VIII, No. 2.

Scientific Papers of the Inst. of Phys. and Chem Res. Nos. 164, 165, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 185, 186, 187, 188, 189, 190, 192, 193, 195, 196, 197, 198, 199, 204, 205, 206. Table No. 3. Supplement to ditto Vols. IX, X and XI.

National Res. Institution of Nanking. Quarterly Meteorological Bulletin, Jan.-Mar., 1928.

National Research Institute, Nanking. Quarterly Meteorological Bulletin, April-June, 1928; July-Sept., 1928; Oct.-Dec., 1928.

Inst. of Meteorology, National Res. Inst., Nanking, China. Monthly Met. Bulletin, March, 1929.

Temperature and Precipitation of Nanking, 1905-1928.

National Res. Council of Japan. Japanese Journal of Engineering.

National Res. Council of Japan. Japanese Journal of Physics.
Aeronautica. Vol. II, No. 12.
Apercu Meteorologique. Les Routes Aériennes de l'Atlantique. A. Baldit.
Elements Createurs du Droit Aérien. Andre Henry Couannier.
Locomotion Aeriénne. Andre Henry Couannier.
Sull & Anaogia fra i campi ellettrici e i campi aerodinamici. C. Ferrari.
Prove Sulla Resistenza Obliqua dell'aria a velocita balistiche a quella del suono. Filippo Furzio.
Extracts from L'Aerotecnica. Concetti e Tendenze nella Costruzione degli Aeroplani Metallici. G. Gabrielli.
Précis de Construction, etc., des Avions et Hydravions. J. Guillemin.
L'Année Aeronautique. 1928-1929. L. Hirschauer and C. Dollfus.
Annales des Postes Telegraphes et Telephones. Paul Joly.
La Propulsion animale dans les Fiuides. Louis Kahn.
Traveaux du Cercle d'Etudes Aerotechniques, Fascicle 1. Les coefficients caractéristiques des turbo-machines et des machines volants. W. Margoulis.
Biblioteca Aeronatica Italiana. L. S. Olschki.
La Navigazione Aerea come Mezzo di Trasporto. M. Panetti.
Extracts from L'Aerotecnica. Sull'Ala Deformabile Sul Comportamento della chiodatura tra lamiere un dural du piccolo spessere. C. Pasqualini and G. Gabrielli.
Alcune considerazioni sul Problema del Biplano Indefinito. E. Pistolesi.
A Proposito di una Supposta Eccezione al Teorema di Kutta-Joukowski. E. Pistolesi.
Contribuito allo Studio dell'Elica innun Vento Laterale. E. Pistolesi.
Nuove Considerazioni sul Problema Dell'Elica in un Vento Laterale. E. Pistolesi.
Les Moteurs Gnomes. Lieut. Remy.
Extracts from L'Aerotecnica La Costruzione Metallica degli Aeroplani. C. Tapinassi.
Remarques sur le Calcul des Efforts dans l'Avion. A. Van der Vliet.
Comite Meteorologique International. Rapport de la Septieme Réunion de la Commission Internationale des Renseignements Synoptiques du Temps à Londres.
Cours de Physique. (Third part.) E. Rothe.
Droit Aerien, April-June, 1929.
Ministère des Affaires Étrangères. Navigation des Avions du Service Commercial pour l'Amérique du Sud. Memoire présenté au I Vème Congres de Navigation Aérienne de Roma par les Aviateurs Portugais.
Notiziario Tecnico di Aeronautica.
Programme of Grande Semaine d'Aviation de la Champagne, First Meeting, 1909.
Reglements de la Rallye Aerien International de l'Aero Club de France. La Baule, 14th September, 1929.
Resoconto del Congresso Annvale dell'Associazione Italiana di Aerotecnica.
Abhundlungen aus dem Aerodynamischen Institute. Heft 8.
Bolem Metrological.
Zum Segelflug Problem. A. Fisher.
Ingeniors Vetenskaps Akademien Flyteniska Konferensen.
Monatsheft fur Mathematik und Physik, XXXVI Band 1 Heft.
Untersuchungen uber die Stromungen des Wassers in Konvergenten und Divergenten Kanalen. Dr. Johann Nikuradse.
The 5,000 Ols-Aero Engine System. Shopik.
Forschungsergenisse des Verkehrswissenschaftlichen Instituts fur Luftfahrt. Carl Pirath.

Travaux du Cercle d'Études Aérotechniques. Fascicule III. Contribution a la Théorie de l'Hélice Propulsive. M. Roy.
Schwingungserscheinungen des Segelflugzeugs Rheinland. F. N. Scheubel.
Schiffbau und Schiffahrt, July, 1929.
Raketen Fahrt. Von Max Valier.
Continuous Flow Round Streamline Bodies with Potential of Velocity. Van der Vliet.
Flugzeug-Kompasse. Zurn, Hackenkroll and Co.

CENTRAL AERO-HYDRODYNAMICAL INSTITUTE OF U.S.S.R. TRANSACTIONS.

No. 20. The Theory of the Induced Drag of Aerofoils. B. N. Jurieff.
No. 21. An Experimental Investigation of the Flow of Air in a Flat Broadening Channel. A. N. Vedernikoff.
No. 22. Gyroscopic Effect of Windmills and Auxiliary Windmill Calculations. G. Sabinin.
No. 24. Detonation Tests of a Napier Lion V Airplane Engine. I. Lissenko.
No. 30. The Central Aero-Hydrodynamical Institute. G. A. Ozeroff.
No. 33. Aerodynamical Investigations. B. N. Jurieff and N. P. Lessnikowa.

CORRECTION

In Mr. North's remarks in the discussion of Colonel Richmond's paper "R.101," in the August JOURNAL, Mr. North was quoted as saying that he did not think that measurement to within an accuracy of 0.030 inches in 45 feet was possible. This should read "impossible."

OBITUARY

It is with very great regret that the Council have to record the deaths of the following members of the Society during the year:—

George Holt Thomas, 1869—1929. *Founder Member*

Mr. Holt Thomas was born in 1869, was educated privately and at Queen's College, Oxford. On coming to town he entered Fleet Street and founded *The Bystander* and afterwards *The Empire Illustrated*. Very early in his career he realised the coming of aircraft and immediately after the famous meeting at Rheims he threw his energies whole-heartedly into aviation. His first step was to persuade Louis Paulhan to fly at Brooklands, and afterwards to enter for the *Daily Mail* prize of £10,000 for the first flight from London to Manchester. Paulhan began his historic flight from a field which now forms part of Hendon Aerodrome.

Following the successful issue of the London-Manchester flight, Mr. Holt Thomas formed the Aircraft Manufacturing Company to construct Farman machines, with Pierre Verrier as his test pilot. Many other famous pilots crossed the Channel to demonstrate the birth of the flying age, and Mr. Holt Thomas took part in numerous flights.

Mr. Holt Thomas' foresight and his keen judgment of men were shown when, about the time of the outbreak of war in 1914, he acquired the services of Geoffrey de Havilland, and the Aircraft Manufacturing Company began the construction of the famous series of D.H. machines, of which the D.H. 2, the D.H. 4 and the D.H. 9 and 9a did outstanding work. During the war Mr. Holt Thomas acquired a controlling interest in a firm at Southampton and built hulls for flying boats.

The years following the war saw a slump in aviation which Mr. Holt Thomas had not fully visualised. The Air Travel and Transport, Ltd., which he formed, was not successful, despite the energies of Mr. Holt Thomas and Sir Sefton

Brancker, who had joined him. But out of the slump grew the de Havilland Aircraft Co., Ltd., and after its formation Mr. Holt Thomas retired from any further active part in aviation, though he gave freely from his wide experience to all who approached him for advice.

Mr. Holt Thomas always took a keen interest in the activities of the Royal Aeronautical Society and served on the Finance Committee for some years. By his death aviation has lost a man who was a genius in his way, a man who saw, as few others have seen, what the future holds for aircraft.

Richard Elwood Bissell

A victim of the Cleveland Clinic disaster which took a toll of over one hundred lives, Richard Elwood Bissell, chief engineer of Thompson Products, Inc., Cleveland, died suddenly May 15th, 1929, at the age of 37 years.

Richard Elwood Bissell was born at Milford, Michigan, September 4th, 1892, and graduated with a degree of Bachelor of Science in 1913. The following year he received a Master of Science degree from the University of Michigan. In 1927 an honorary degree in metallurgical engineering was conferred upon him by Michigan State College in recognition of contributions he had made to automobile progress. He went with Thompson Products, Inc., ten years ago as head of the metallurgical department, and was made chief engineer last October.

Richard Elwood Bissell was a member of the Society of Automotive Engineers, and an Associate of the Society.

Lieut.-Colonel Sir Alan Burgoyne

Sir Alan Burgoyne joined the Society in 1917, and was a Member of Council from 1918-1920.

Sir Alan Burgoyne, who was born on September 30th, 1880, was a man of wide interests and took a particular interest in the Navy and the Air Force. For some years he was Hon. Treasurer of the Navy League and founded and edited the *Naval League Annual*. From 1916-1918 he was Hon. Secretary of the Parliamentary Air Committee, and Treasurer 1919-20.

H. G. Locell

Mr. H. G. Locell was a Founder Member of the Society, and one of its most enthusiastic supporters.

Captain King Paton

Captain King Paton was elected an Associate Fellow of the Society in 1919, and during the ten years he was a member he took the keenest possible interest in the Society.

Pilot Officer Walter Patrick Dillon Bennett

Pilot Officer W. P. D. Bennett, who became a Student Member of the Society in February, 1929, died as the result of an accident near Boreham Wood, Hertfordshire, to a D.H.60. Pilot Officer Bennett was on the Reserve of Air Force Officers and at the time of the accident he was the sole occupant of the machine.

Wing-Commander John Dunville

Wing Comdr. John Dunville, C.B.E., R.A.F., who was a Founder Member of the Society, died on June 10th, 1929. Wing Comdr. Dunville will always be remembered by a very wide circle of friends for his enthusiastic and practical support of aviation during its pioneering days. He made his first flight in a balloon in 1906 with the late the Hon. Charles Rolls, and from then onwards was a

ballooning enthusiast. Two years after his first ascent he made a record for duration for a British balloon in the Gordon Bennett Race, remaining in the air 36 hours 56 minutes, and twice he won the challenge cup offered by the late Lord Northcliffe for the British balloon covering the longest distance in the year.

An early member of the Royal Aero Club, Mr. Dunville, as he was then, became keenly interested in the development of the aeroplane and was very actively engaged on the committee of the Club organising meetings. On the outbreak of war his wide ballooning experience was made use of in the Royal Naval Air Service, for training officers for balloon and airship work. He was made an Hon. Wing Commander, R.A.F., in 1926.

Squadron-Leader Lord Edward Grosvenor

By the death of Squadron Leader Lord Edward Grosvenor, at the early age of 37, aviation has lost one of its most engaging personalities. It is a commentary in itself on the youthfulness of aviation that a man so young as Lord Edward Grosvenor can be regarded as one of the pioneers of the air. There is a framed photograph in the Secretary's room at the Society's office, the legend underneath reading, " No. 1 (Airship) Squadron, Royal Flying Corps, Military Wing, Army Manœuvres, 1913." Two of the centre figures in the group are Major E. M. Maitland and Lord Edward Grosvenor.

Lord Edward Grosvenor joined the Royal Horse Guards in 1912 and in that year bought a Blériot monoplane on which he learnt to fly. He served throughout the war in France and Italy and was awarded the M.C. At the time of his death Lord Edward Grosvenor was Squadron Leader of No. 601 (County of London) (Bomber) Squadron, Auxiliary Air Force. Lord Edward Grosvenor was an Associate Fellow of the Society.

Dr. T. Blackwood Murray

Dr. T. Blackwood Murray, who died on June 11th, 1929, was elected a Fellow of the Society in 1919. He was a brilliantly qualified engineer, a former President of the Institution of Engineers and Shipbuilders in Scotland. Dr. Murray carried out a considerable amount of research work on aero engine design and lubrication.

C. S. Payne

Mr. C. Spencer Payne, B.Sc., M.C., died in St. Thomas' Hospital after a short but severe illness. Mr. Payne joined the Society in 1912 and always took a keen interest in aviation. As long ago, as time is reckoned in aviation, as 1907 Mr. Payne gave a series of lectures on aeronautics at Sheffield University. He was a member of many other scientific bodies and on the outbreak of war in 1914 he was engaged on the design of airships.

M. A. S. Riach

By the death of M. A. S. Riach, at the early age of 37, the Society lost one of its most brilliant Fellows. Mr. Riach was handicapped for many years by illness, and unable to leave such a mark on aviation which he otherwise undoubtedly would have done.

Mr. Riach was the eldest son of Colonel M. S. Riach, and was educated at Wellington College and the Armstrong Engineering College, Newcastle-on-Tyne. From his earliest days he took a great interest in aeronautics. After a short course at the London Polytechnic he was apprenticed to the late Mr. Holt Thomas and prior to and during the War he was concerned with the design of propellers with Mr. Grahame White. Afterwards, at the Air Ministry, he was concerned with Mr. Louis Brennan in the design of the latter's helicopter. Mr. Riach

published many papers on airscrews and a book on the subject in 1916. Mr. Riach was one of the youngest Fellows of the Society, to which grade he was elected in 1917.

Katharine Wright Haskell

> " WRIGHT HASKELL. On Sunday, March 3, 1929, from pneumonia, at Kansas City, Katharine Wright Haskell, wife of Harry Haskell, only daughter of the late Bishop Milton Wright and sister of Wilbur and Orville Wright. Funeral at Dayton, Ohio, to-day (Wednesday)."

The above notice appeared in the *Times* on the 6th March and seems to have passed unnoticed. It is sad to think that human memory is so short that twenty years can obliterate the memory of some of our best friends. Yet, twenty years ago, Katharine Wright accompanied her brothers, Wilbur and Orville Wright, through France, Italy, Germany and England, in the first demonstration in Europe of actual flying. During that time she met King Edward, King Alphonso, and the leading Presidents and people on this side of the Atlantic, and her charm made her fast friends with many people in this country. She did not forget her friendship for England; for, on the 6th June, 1916, Lord Northcliffe, in speaking before the Royal Aeronautical Society before America had come to our assistance in the Great War, quoted a letter he had received from Katharine Wright, in which she said: " We here make no pretence at being neutral—we are heart and soul for England and her Allies in this great struggle." Members of the Society will remember that it was after this that Lord Northcliffe went to America, and by his eloquence and earnestness played such a valuable part in securing the wholehearted co-operation of America in the European struggle for freedom.

We have, therefore, not merely to remember Katharine Wright for the encouragement and help which she gave to her brothers at a time when sympathy and comfort were most required in the attainment of flight; but we, as a nation, have to remember her with grateful feelings for the part which she contributed in securing the co-operation of an ally of overwhelming power, at the time when our very existence was in peril.

G. B.

REVIEW

Airplane Structures

Niles and Newell. John Wiley and Sons.

" The size of the airplane also has an influence on the design procedure. In a small airplane it is often cheaper to build as the design is being worked out, changing the structure when necessary, than to attempt to work out the design in detail on the drawing board first. For large airplanes, however, or for designs that must be worked out to get the very maximum possible performance, the reverse is the case."

This quotation, from " Airplane Structures," by Niles and Newell (John Wiley and Sons), emphasises the different outlook on aircraft design which obtains on the other side of the Atlantic.

Whether this freedom, due to the absence of Government supervision of aircraft design, is beneficial or adverse is open to question.

In a book which claims to be " prepared with the twofold purpose " of meeting " the needs of instructors giving courses in airplane structures " and satisfying " the ordinary requirements of the practical engineer," such an outlook is not customary in this country.

This twofold purpose is evident in many parts of the book which alternates between a purely mathematical examination of structures and tables for direct use, taken from " Handbook of Instructions for Airplane Designers," U.S.A. Army Air Corps, or drawn up for " Airplane Structures."

Of the eleven chapters which are devoted to the determination of stresses, six deal with the more general cases and five with combined stresses more particularly applicable to aircraft. This section on stresses is not continuous but is broken by chapters devoted to tables and graphs on steel tubes, ties, cables, brazing, glueing and other joints. This sandwich compilation of the book complicates its use for either of the twofold purposes.

The final chapter on weight estimation has much useful data for designers using American components. The weights of various cameras, parachutes, instruments, wireless sets, oleopneumatic undercarriage struts, wheels, tyres, airscrews, engines, etc., are given and bring into a few pages much valuable data.

The book is worth a place on the designer's bookshelf. The tables of characteristics and recorded load factors of many American aircraft provide information which is not readily available from other sources. The chapters on stresses, which comprise the greater part of the book, would form a foundation for lectures to students.

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

JANUARY 1929

Preliminary Notices

At a Council Meeting held on December 11th, 1928, it was decided that certain alterations should be made in the JOURNAL to bring it more into line with the Proceedings and Journals of other Scientific and Engineering bodies. The principal alteration involved is the substitution of an inset circular in the JOURNAL each month in place of the Preliminary Notices. Much of the matter which has appeared in the Preliminary Notices in the past is of an ephemeral nature. Such matter which should be placed on record will be embodied in the Annual Report of the Council and printed in the March or April JOURNAL of each year.

Informal Discussion and Dinner

On Thursday, January 24th, 1929, an Informal Discussion and Dinner will be held at 7.30 p.m., at the St. Ermin's Hotel, Caxton Street, Westminster, S.W.1. The subject for discussion will be "The Compression Ignition Engine." The case for the Compression Ignition Engne will be stated by Wing Commander G. B. Hynes, D.S.O., and the case for the Petrol Engine by Captain G. S. Wilkinson, A.F.R.Ae.S., of Messrs. Napiers. The chair will be taken by the President, Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S.

In the past these Informal Discussions have proved very successful. Their informality enables those who wish to speak to do so more freely than at a lecture, and with the knowledge that any of their remarks they do not wish reported are not taken down. Speakers, too, may intervene in the debate as often as they wish as points are raised about which they would like further information.

The price of the tickets is 6/6 each, and members may bring guests. Ladies are not admitted to these discussions. As the accommodation is strictly limited it is necessary for those who wish to come to *notify the Secretary as early as possible*, so that seats may be reserved. An application form is enclosed with the January JOURNAL.

Lantern Slides

The Council acknowledge with gratitude the receipt of the following slides from the Gloster Aircraft Company:—

Gloster IV.
Gloster Goring on Floats.
Gloster Goldfinch.
Gloster Gamecock II.
Gloster Gambet.
Gloster Grebe for New Zealand.

These slides have been added to the Society's Loan Collection.

Lecture Programme

The following lectures have been arranged for the second half of the 1928-29 Session :—

January 10th.—Professor B. Melville-Jones, A.F.C., F.R.Ae.S., "The Performance of the Streamline Aeroplane."

January 31st.—Mr. W. S. Farren, F.R.Ae.S., M.I.Ae.E., "Monoplane or Biplane?"

February 14th.—Mr. A. H. R. Fedden, F.R.Ae.S., "Air-Cooled Engines in Service."

February 28th.—Mr. R. A. Frazer, B.Sc., A.F.R.Ae.S., "The Flutter of Aeroplane Wings."

March 7th.—Mr. C. N. H. Lock, "Airscrew Body Interference."

March 14th.—Wing Commander G. B. Hynes, D.S.O., R.A.F., "Engine Performance Tests."

March 18th.—M. Isacco, "The Helicogyre."

April 11th.—M. Lapresle, "Wind Tunnel Methods of the Eiffel Laboratory."

April 18th.—Colonel V. C. Richmond, O.B.E., A.F.R.Ae.S., "R.101."

Arrangements are being made for lectures to be given, in addition to the above, by Major G. H. Scott on "The Mooring and Handling of Rigid Airships"; Squadron-Leader C. L. Scott on "The Iris Flight"; and Captain Sinclair on "Wireless in Aircraft." The dates for these lectures will be announced in due course.

Advance proofs of lectures can be obtained for sixpence each, a few days before its delivery, or they will be posted regularly on prepayment of 4s. 6d. for the whole series.

All the lectures will take place at the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m., with the exception of that on February 14th. This lecture is a joint one with the Institution of Automobile Engineers and will begin at 7.45 p.m.

Medals and Awards

At a meeting of Council held on December 11th, 1928, it was decided to adopt the following recommendation of the Medals and Awards Committee :—

> That the year for awarding all medals and prizes should be from July 1st to June 30th. In the case of the R.38 and Busk Memorial awards the dates for entry this year should be advanced from their present dates of September 30th and December 31st, 1928, to March 31st, 1929, and that the papers should be delivered to the Secretary by June 30th.

The Committee also recommended and the Council adopted the following resolution :—

> That the Wilbur Wright Memorial Lecture should not be included in the lectures to be considered for the awards of any medals and prizes by the Society.

Taylor Gold Medal

The Taylor Gold Medal has been awarded by the Council to Mr. R. K. Pierson, B.Sc., A.M.Inst.C.E., F.R.Ae.S., for his paper on "The Use of the Wind Tunnel for Performance Prediction." The paper was published in the JOURNAL for February, 1928.

Simms Gold Medal

The Simms Gold Medal has been awarded by the Council to Captain F. Entwistle for his paper on "Fog." The paper was published in the JOURNAL for May, 1928.

Sir Charles Wakefield Gold Medal

The Sir Charles Wakefield Gold Medal has been awarded by the Council to Mr. Handley Page, C.B.E., F.R.Ae.S., for his work in connection with the Automatic Slot.

Silver Medal

The Silver Medal of the Society has been awarded to Mr. B. N. Wallis for his work in connection with R.100.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on December 10th, 1928:—

Fellows.—Robert Arthur Bruce (transferred from Associate Fellow), Cecil Hugh Latimer Needham (transferred from Associate Fellow), George Tilghman Richards (re-elected).

Member.—George Tilghman Richards (re-elected).

Associate Fellows.—Alfred Charles Brown, Albert Thomas Cross, Victor Reginald Scriven.

Associate Members.—Sydney Baldwin, John Sharples Charnley, Thomas Courtenay Head, Harold Bertram Pond.

Associates.—Joseph William Hay Barrett (transferred from Student), William Thomas Harriden, Harold Parkinson, Frank Horsfield Spencer, Frank Whittle.

Student.—Purshottam Meghji Kabali.

Companions.—Sydney Goldstein (transferred from Student), Madame de Landa.

World Engineering Congress

A World Engineering Congress will be held in Tokyo in October-November, 1929. The object of the Congress is to effect an international exchange of the latest knowledge of the sciences and practices of engineering and to bring together the leaders in research, education or business who are directing the trend of engineering activities.

A Conference of representatives of Engineering Institutions was held at the Institution of Civil Engineers on Monday, December 10th, 1928, at which it was agreed:—

1. That the representatives of the Institutions and Societies which had accepted invitations to take part in the Conference should be constituted a Committee to be entitled "*The British Committee on the World Engineering Congress in Japan,*" with Sir Brodie Henderson as its Chairman, and having its Secretariat and its place of meeting provided by the Institution of Civil Engineers, and that it should have powers to extend its membership to Engineering Institutions.

2. That the Committee should have as its objects:—

(*a*) The organisation of a party of British Engineers to attend the World Engineering Congress at Tokyo.

(*b*) The securing of a number of Papers on engineering subjects for presentation at that Congress.

3. That the Committee should confine its activities to matters relating to the World Engineering Congress and should not concern itself with the Sectional Meeting of the World Power Conference which is being held in Tokyo at the same time; but that liaison be maintained with the organisers of that Conference by the exchange from time to time of information as to the arrangements which are being made.

4. That a small Executive Committee consisting of the following members be appointed to examine in detail the means by which the objects for which the Committee has been constituted may be furthered:—

Sir Brodie Henderson (Chairman).

Mr. R. W. Allen.	Professor P. A. Hillhouse.
Sir John Biles.	Mr. Archibald Page.
Sir Alexander Gibb.	Mr. E. F. C. Trench.

The Secretary was instructed to communicate with the Councils of the Institutions represented on the Committee informing them of the result of the meeting, asking whether they propose to send one or more official representatives to the Congress, and requesting that they should circularise their members inviting them to attend the Congress as members of the British party and to contribute Papers thereto through this Committee.

The following are general directions with regard to Papers:—

1. Papers shall be typewritten, using double spacing, on one side of the page only. Papers should, as far as possible, not exceed 8,000 words. Papers, accompanied with two copies, should reach the Secretary of the World Engineering Congress not later than April 1st, 1929.

2. No special restriction is put upon the number of papers to be presented by a single contributor.

3. Each Paper shall be accompanied by an abstract in English, preferably not to exceed 500 words. A brief description of the author's career should also be attached.

4. Drawings and diagrams shall be made in jet black ink on white paper. Letterings shall be in plain block letters. Special attention should be paid in order to facilitate reducing the size of drawings and diagrams suitable for the Papers. Photographs should be clear prints ready for reproduction without re-touching.

5. The Technical Programme indicates the scope of the subjects to be dealt with, but not necessarily the titles of the Papers.

6. Advance copies of Papers will be ready for distribution before the opening of sessions.

7. Papers presented at the Congress will be published, either in full, or in abstract, in the Proceedings of the World Engineering Congress.

The Technical Programme of the Congress is divided into twenty-three sections, of which the following are of interest to aeronautical engineers:—

2. Engineering Science:—Strength of Materials, Thermodynamics, Hydraulics, Electricity and Magnetism, and other Scientific Researches.

7. Transportation:—Land, Water and Aerial Transportation.

16. Aeronautical Engineering:—Aerodynamics, Aeroplanes, Dirigibles, Aero Engines, Air Propellers, Equipment, Instruments, etc.

The Council hope that as many members as possible will submit Papers for forwarding to the Congress. Papers, if possible, should be submitted by the end of February at the latest.

Subscriptions of Members

Members are reminded that all annual subscriptions become due on January 1st. The rates are:—

	Home.			Abroad.		
	£	s.	d.	£	s.	d.
Fellow	4	4	0	3	3	0
Member	4	4	0	3	3	0
Associate Fellows	3	3	0	2	2	0
Associate Members	3	3	0	2	2	0
Associates	*2	2	0	*2	2	0
Students	1	1	0	1	1	0
Companions	2	2	0	2	2	0
Founder Members	2	2	0	2	2	0

* £1 1s. 0d. without Journal.

Library

The following have been received and placed in the Library:—

The Aeronautical Research Committee:—

Technical Report for 1926-27.

R. & M. No. 1154. Wind Tunnel Experiments on a Model Autogyro at Small Angles of Incidence. C. N. H. Lock and H. C. H. Townend.

R. & M. No. 1166. The Force Acting on a Body Placed in a Curved and Converging Stream of Fluid. G. I. Taylor.

Air Publication 1346. Supercharger Unit as Fitted to the Jaguar IV. Engine.

Central Aero-Hydrodynamical Institute of U.S.S.R. Transactions:—

No. 20. The Theory of the Induced Drag of Aerofoils. B. N. Jurieff.

No. 21. An Experimental Investigation of the Flow of Air in a Flat Broadening Channel. A. N. Vedernikoff.

No. 22. Gyroscopic Effect of Windmills and Auxiliary Windmill Calculations. G. Sabinin.

No. 24. Detonation Tests of a Napier Lion V. Airplane Engine. I. Lissenko.

No. 30. The Central Aero-Hydrodynamical Institute. G. A. Ozeroff.

No. 33. Aerodynamical Investigations. B. N. Jurieff and N. P. Lessnikowa.

Reports of the Aeronautical Research Institute, Tokyo:—

No. 42. On the Acoustical Properties of Conical Horns. R. Sato-Kozi.

No. 43. The Theory and Design of a New Carburettor. M. Isikawa.

No. 44. On the Interference of Wind Tunnel Walls of Rectangular Cross-Section. K. Terazawa.

British Engineering Standards Association:—

British Standard Specifications for Aircraft Materials and Components.

[4 K.6 October, 1928] Cast Iron Piston Ring Pots.

[3 S.1 July, 1928] (cancelling B.S. Specification 2 S.i.—Pt. 1 and S.35) Bright Steel Bars.

Smithsonian Reprints:—
Isaac Newton. A. Einstein.
Soaring Flight. W. Klemperer.
Geological Climates. W. B. Scott.
At the North Pole. L. Ellsworth.

Travaux du Cercle d'Etudes Aérotechniques, Fascicule I.:—
Les coefficients caractéristiques des turbo-machines et des machines volantes. W. Margoulis.

Civil Aeronautics. Revision of 1923 Edition of Law Memoranda upon Civil Aeronautics. Office of the Legislative Counsel, Washington.
Strain Energy Methods of Stress Analysis. A. J. Sutton Pippard.
The First English Aeronaut: James Sadler, of Oxford (1753-1828). J. E. Hodgson. (Reprinted from *Cornhill*).
The Story of a North Sea Air Station. C. F. Snowden Gamble.
Wessex from the Air. A. G. S. Crawford and A. Keiller.
The Zeppelins. E. Lehmann and H. Mingos.
The Airplane and its Engine. C. F. Taylor and C. H. Chatfield.
Alkaline Accumulators. J. T. Crennell and F. M. Lea.
Aeroplanes, Seaplanes and Aero Engines. P. H. Sumner.
Aluminium Sheet Metal Work, No. 296. British Aluminium Co.
Apercu Meteorologique. Les Routes Aériennes de l'Atlantique. A. Baldit.

Forthcoming Events

January 10th.—Professor B. Melvill Jones, A.F.C., F.R.Ae.S., will lecture on "The Streamline Aeroplane" at the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

January 24th.—Informal Discussion and Dinner at the St. Ermin's Hotel, Caxton Street, Westminster, at 7.30 p.m. The subject for discussion will be "The Compression Ignition Engine for Aircraft."

January 31st.—Mr. W. S. Farren, F.R.Ae.S., M.I.Ae.E., will lecture on "Monoplane or Biplane?" at the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

J. LAURENCE PRITCHARD, *Secretary*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

---

MONTHLY NOTICES

FEBRUARY 1929

Subscriptions

Members are reminded that their subscriptions for the current year fell due on January 1st, 1929. The attention of all members is drawn to Rule 70, which reads as follows:—

> "Any Fellow, Member, Associate Fellow, Associate Member, Associate, Student, Companion, or Founder Member, whose subscription shall not have been paid before the first day of April, shall be in arrears of subscription and shall not be entitled to attend or vote at any meeting or to receive any publications to which he would be otherwise entitled."

Journal Binding

Members who wish to have their JOURNALS bound are reminded that they can do so by forwarding a remittance of 4s. 6d. for the 1928 volume, and 5s. 6d. for former volumes, to this office, and sending their JOURNALS, with their name and address, to the Lewes Press, High Street, Lewes, Sussex. The JOURNALS will be bound and returned to them, post free.

Elections to Council

The Annual General Meeting will be held towards the end of March. At that meeting the voting papers for new members of Council will be counted.

The attention of members is called to Rule 88, which reads:—

> "Nominations of candidates for election to the Council must be received by the Secretary not less than twenty-one days before the Annual General Meeting, with an intimation in writing by the candidates that they are willing to serve. Nominations must be signed by one supporter and two seconders, who must be each entitled to vote in the R.Ae.S.I."

Photographs

During the last few months the large collection of photographs of aircraft of all types which the Society possesses has been classified by Mr. Howard-Flanders. The work of arranging these photographs and identifying them has been difficult, and the Council wish to place on record their grateful thanks to Mr. Howard-Flanders for the great amount of time which he gave to the work.

Council Meeting

A meeting of Council was held on Wednesday, January 9th, 1929. Present:

Colonel the Master of Sempill, President, in the chair.

Captain P. D. Acland.	Major A. R. Low.
Mr. M. L. Bramson.	Major R. H. Mayo.
Major J. S. Buchanan.	Mr. H. E. Wimperis.
Mr. F. T. Hill.	Mr. R. McKinnon Wood.
Captain A. G. Lamplugh.	

Among the items on the agenda which were considered were the formation of certain new branches; co-operation with the Society of British Aircraft Constructors over the International Aircraft Exhibition to be held in July at Olympia; Elections of Members; and Finance Committee's Report.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Wednesday, January 9th, 1929:—

Fellows.—Mogens Louis Bramson (transferred from Associate Fellow), Reginald Joseph Mitchell (transferred from Associate Fellow), Joseph Lawrence Nayler (transferred from Associate Fellow), Ernest Ower.

Associate Fellows.—Albert Arthur Hammond (transferred from Student), James Kewley, Arthur Cyril Thornton, Theodore Paul Wright.

Associate Members.—George Oswald Anderson, Archibald Henry Harrison.

Associates.—Cyril Gordon Burge, Alfred Leonard Ford (transferred from Student), Harry Higgins.

Students.—Clement James Selden, John Emmerson Walker.

Aero Exhibition, Olympia, 1929

The Rules and Regulations for the 7th International Aero Exhibition to be held at Olympia, July 16th to 27th, 1929, may be obtained, together with the necessary application forms for space, from the Exhibition Manager, at 83, Pall Mall, S.W.1.

Wright Anniversary Dinner

A letter has been received by the President from W. P. MacCracken, Jr., Assistant Secretary of Commerce for Aeronautics, Washington, in which he says, in reply to a letter from the President:—

> "Your kind letter of December 18th enclosing a list of the members and guests present at the dinner of the Royal Aeronautical Society in the Science Museum, at South Kensington, has been received.
>
> "I very much appreciate your thoughtfulness in sending this to me and assure you it will be preserved with the records of the International Civil Aeronautics Conference, which closed with the pilgrimage to Kitty Hawk on the anniversary of the Wright Brothers' flight."

Institute of Metals

On March 13th and 14th the Institute of Metals will hold their Twenty-First Annual General Meeting and "Coming-of-Age" celebrations. The annual dinner of the Institute will be held at the Trocadero Restaurant on Wednesday, March 13th, at 6.45 p.m. for 7 p.m. The dinner will be followed by a dance. Full particulars of the dinner and dance may be obtained from G. Shaw Scott, Esq., 36, Victoria Street, London, S.W.1.

Forthcoming Arrangements

February 2nd.—Visit by Students' Section to S. Smith and Sons.

February 6th.—Lecture before Yeovil Branch.

February 8th.—Lecture before Students' Section at 6.30 p.m., in the Library, by Mr. H. T. Edgecombe.

February 14th.—Joint Lecture with the Institution of Automobile Engineers, by Mr. A. H. R. Fedden on "Air-Cooled Engines in Service." The lecture will be at 7.45 p.m., in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2.

February 15th.—Lecture before the Yeovil Branch by Dr. E. G. Richardson on "Model Aerofoil Experiments."

February 18th.—Lecture before the Halton Branch on the H.A.C.3.

February 20th.—Lecture before the Yeovil Branch by Major J. H. Ledeboer.

February 22nd.—Lecture before the Students' Section at 6.30 p.m., in the Library, by Mr. L. T. Brown on the "Napier Lion Engine."

February 26th.—Lecture before the Leeds Branch by Mr. N. S. Norway on "Control of Rigid Airships."

February 28th.—Lecture by Mr. R. A. Fraser, at 6.30 p.m., in the Lecture Hall of the Royal Society of Arts, on "Flutter of Aeroplane Wings."

J. LAURENCE PRITCHARD, *Secretary.*

OBITUARY

George Holt Thomas, 1869—1929

Founder Member

It is with great regret that the Council record the death of George Holt Thomas, a Founder Member of the Society, and one of the best known pioneers of aviation.

Mr. Holt Thomas was born in 1869, was educated privately and at Queen's College, Oxford. On coming to town he entered Fleet Street and founded *The Bystander* and afterwards *The Empire Illustrated*. Very early in his career he realised the coming of aircraft and immediately after the famous meeting at Rheims he threw his energies whole-heartedly into aviation. His first step was to persuade Louis Paulhan to fly at Brooklands, and afterwards to enter for the *Daily Mail* prize of £10,000 for the first flight from London to Manchester. Paulhan began his historic flight from a field which now forms part of Hendon Aerodrome.

Following the successful issue of the London-Manchester flight, Mr. Holt Thomas formed the Aircraft Manufacturing Company to construct Farman machines, with Pierre Verrier as his test pilot. Many other famous pilots crossed the Channel to demonstrate the birth of the flying age, and Mr. Holt Thomas took part in numerous flights.

Mr. Holt Thomas' foresight and his keen judgment of men were shown when, about the time of the outbreak of war in 1914, he acquired the services of Geoffrey de Havilland, and the Aircraft Manufacturing Company began the construction of the famous series of D.H. machines, of which the D.H. 2, the D.H. 4 and the D.H. 9 and 9a did outstanding work. During the war Mr. Holt Thomas acquired a controlling interest in a firm at Southampton and built hulls for flying boats.

The years following the war saw a slump in aviation which Mr. Holt Thomas had not fully visualised. The Air Travel and Transport, Ltd., which he formed, was not successful, despite the energies of Mr. Holt Thomas and Sir Sefton Brancker, who had joined him. But out of the slump grew the de Havilland Aircraft Co., Ltd., and after its formation Mr. Holt Thomas retired from any further active part in aviation, though he gave freely from his wide experience to all who approached him for advice.

Mr. Holt Thomas always took a keen interest in the activities of the Royal Aeronautical Society and served on the Finance Committee for some years. By his death aviation has lost a man who was a genius in his way, a man who saw, as few others have seen, what the future holds for aircraft.

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

MARCH 1929

Annual General Meeting

The Annual General Meeting will be held on Tuesday, March 26th, at 5.30 p.m. in the Offices of the Society, 7, Albemarle Street, W.1.

The attention of members is drawn to the Council's Report printed in this issue of the JOURNAL and also the Balance Sheet and Income and Expenditure Account of Aerial Science, Ltd.

Any member who wishes to submit any resolution to the Annual General Meeting must do so in writing to the Secretary by March 11th.

Elections to Council

Nominations for election to the Council must be received by the Secretary by Tuesday, March 5th, under Rule 88. Nominations must be signed by one supporter and two seconders, all voters in the R.Ae.S.I., and must be accompanied by an intimation in writing by the candidate that he is willing to serve.

Council Meeting

A meeting of Council was held on Tuesday, February 5th, 1929. Present:—

Colonel the Master of Sempill, President, in the chair.

Captain P. D. Acland.	Mr. W. O. Manning.
Mr. M. L. Bramson.	Mr. T. O. M. Sopwith.
Major J. S. Buchanan.	Sir Vyell Vyvyan.
Mr. G. Brewer.	Mr. H. E. Wimperis.
Wing Comdr. T. R. Cave-Browne-Cave.	Mr. L. A. Wingfield.
	Mr. R. McKinnon Wood.

Among the items on the agenda which were considered were the application to form a branch at Bristol; the Report of the Grading Committee; the Annual Report of the Council; the Report of the Finance Committee; consideration of the Balance Sheet and Income and Expenditure Account of Aerial Science, Ltd., for the year 1928; and the date and arrangements for the Annual General Meeting.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Tuesday, February 5th, 1929:—

Associate Fellows.—Isidor Levy (transferred from Student), Christopher Noel Hunter Lock, Frank Morgan Owner, Robert Allan Powell.

Associate Members.—John Alexander McCulloch (re-elected), Herbert Percival Strong.

Associate.—Thomas Henry Turner.

Students.—Walter Patrick Dillon Bennett, Frederick Henry Carey, Christopher Ainsworth Davis, Edward Lucas Mole, Robert John Feltham Waight.

Companions.—Charles Edward Thomas Maguire (transferred from Student), Richard Oliver Irving Muntz, A. F. Sidgreaves, A. R. Stevenson, Jun. (re-elected).

Akroyd Stuart Prize

Papers for the Herbert Akroyd Stuart Prize, for the years 1927-29, must be received by June 30th next. The prize, which is of the value of approximately £68, is awarded for the best paper on the subject of "The Origin and Development of Heavy Oil Aero Engines."

Branches

COVENTRY BRANCH.

Very successful lectures were delivered before the branch in December on "Seaplanes," by Mr. Lankester Parker; and on February 19th, by Mr. H. B. Taylor, on "Compression Ignition Engines."

A lecture has been arranged for an evening in March, to be fixed, on "Wind Channels," by Mr. Reynolds, and it is hoped to arrange for a lecture on "Airships" in April. In March a visit will be paid by members to Cardington to inspect R.101. It is hoped to be able to organise visits to the R.A.F. Pageant, the Aeronautical Exhibition at Olympia and the Schneider Trophy Race.

BRISTOL BRANCH.

A new branch of the Society has been formed at Bristol, with Professor A. J. Sutton Pippard, D.S.C., M.Inst.C.E., F.R.Ae.S., as Chairman, and C. W. Tinson, Esq., F.R.Ae.S., as Hon. Secretary. The branch held their first meeting in the Merchant Venturers' College on February 28th.

MANCHESTER BRANCH.

Very successful meetings of the Manchester Branch were held on Friday, January 18th, when Mr. Hackett read his paper on "Steel Tube Manipulation," and on February 8th, when Mr. Kerry read a paper on "The Evolution of the Aeroplane."

Forthcoming Arrangements

March 4th.—Group Captain H. M. Cave-Browne-Cave, D.S.O., D.F.C., F.R.Ae.S., will lecture on "The Royal Air Force Far East Flight," in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, Embankment, W.C.2, at 6.30 p.m.

March 7th.—Mr. C. N. H. Lock, A.F.R.Ae.S., will lecture on "Airscrew Body Interference," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

March 8th.—Mr. E. N. B. Bentley will lecture before the Students in the Library of the Society, at 6.30 p.m., on "The Case for Aircraft in Coast Defence."

March 9th.—Visit to the Works of the Whitehead Torpedo Co., Ltd., by members of the Yeovil Branch.

March 14th.—Wing Comdr. G. B. Hynes, D.S.O., R.A.F., will lecture on "Engine Performance Tests," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

March 15th.—Mr. L. T. Brown will lecture before the Students in the Library of the Society, at 6.30 p.m., on "The Napier Lion Engine."

March 18th.—M. Isacco will lecture on "The Helicogyre," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

March 26th.—Annual General Meeting at the Offices of the Society, 7, Albemarle Street, W.1, at 5.30 p.m.

J. LAURENCE PRITCHARD, *Secretary.*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

APRIL, 1929

Annual General Meeting

The Sixty-Fourth Annual General Meeting of members of the R.Ae.S.I. was held in the Library at 7, Albemarle Street, W.1, at 5.30 p.m., on Tuesday, March 26th, 1929. Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., President of the Society, was in the chair.

The following members were present:—Captain P. D. Acland, Mr. R. M. Balston, Commander Boothby, Major J. S. Buchanan, Major Bulman, Mr. R. S. Capon, Wing Commander T. R. Cave-Browne-Cave, Mr. C. R. Fairey, Lieut.-Colonel L. F. R. Fell, Mr. H. R. Gillman, Mr. Glaser, Capt. F. T. Hill, Mr. J. E. Hodgson, Capt. Lamplugh, Mr. W. O. Manning, Major R. H. Mayo, Mr. G. Merton, Mr. F. Handley Page, Mr. E. L. Pickles, Flight Lieut. R. Chevallier Preston, Mr. H. P. Savage, Mr. T. O. M. Sopwith, Dr. A. P. Thurston, Mr. F. Tymms, Mr. H. E. Wimperis, and Mr. R. McKinnon Wood.

The notice convening the meeting was read, and the Minutes of the last General Meeting, having been published in the Journal for April, 1928, were taken as read and signed.

The President referred to the slow rate of increase in the membership during 1928, and stated he thought it was due largely to the stiffening of the conditions of entry in the technical grades under the new rules. He pointed out that the number of members elected during the first three months of 1929 gave promise of considerably better figures for the current year.

The Endowment Fund now stood at £1,047, and the President expressed the hope that members would realise the importance of the Fund, the objects of which were to provide a permanent building for the Society and an income for its maintenance.

In commenting on the numerous donations which the Society had received the President mentioned that the Society of Motor Manufacturers and Traders, through the good offices of Mr. F. R. Simms, had repeated their donation of £250, first made in 1928.

After referring to the list of awards printed in the Council's Report, the President said that the Society's Gold Medal, which is the highest honour the Society can confer, was first instituted in 1909, when it was bestowed on the Brothers Wright. Only 5 awards of the medal had been made since that time.

The President expressed satisfaction at the better attendances of members at the lectures. A discussion on the most suitable hour for lectures took place, and the majority of the members present were in favour of keeping to 6.30 p.m., and of strictly limiting the time of reading papers to 40 minutes.

Referring to the Wright celebrations in 1928 the President stated that it was hoped that an American would deliver the Wright Memorial Lecture for

1929 on some date between July 16th and 26th, when the International Aircraft Exhibition would be taking place.

The President drew attention to the satisfactory way in which the Branches of the Society were proceeding, stating that he had visited several of them in person and had found them doing excellent work, thanks to the energy of their Chairmen and Honorary Secretaries. The one new Branch of 1928, that at Oxford, had made a very good beginning. A new branch had been formed at Bristol early this year and had already over a hundred members.

A very hearty vote of thanks was accorded to Mr. J. E. Hodgson (Honorary Librarian) when the President gave details of the enormous amount of time, labour and invaluable knowledge he had put into the organisation of the Society's exhibit at the International Aeronautical Exhibition at Berlin last year, which resulted in the exhibit having been widely declared the finest that had been seen. If it had not been for the loan of his own valuable prints, books, and other historical objects—all of which, together with the others he had collected for the occasion, he had arranged at his own expense, and at a great deal of personal inconvenience—the result would have been very different.

The President expressed the thanks of the Society to Captain Acland and the Society of British Aircraft Constructors who were giving the Society free space in the Gallery of Olympia for the housing of an historical exhibit at the International Aircraft Exhibition which is to take place between July 16th and 26th. Negotiations with foreign aeronautical societies were in hand, and it was probable that France, Germany, Italy and Russia would be showing exhibits.

An outline was given of the arrangements being made for the delivery of papers on behalf of the Society during the forthcoming World Engineering Congress at Tokyo. The full list of the papers and the representatives of the Society being :—

DELEGATES TO WORLD ENGINEERING CONGRESS, TOKYO.

Dr. G. V. Lachmann, A.F.R.Ae.S., Technical Adviser to the Ishikawajima Aircraft Works, Tokyo.

Taizo Shoda, Esq., of Messrs. Kokuki Kaisha, Ltd., Atsuta, Nagoya, Japan (Companion).

Major C. H. Chichester Smith, A.F.R.Ae.S., Representative of the Blackburn Aeroplane and Motor Co., Ltd., in Japan.

Professor Aikitu Tanakadate, Zosigayamati, Tokyo-si (Companion).

Anthony Vickers, Esq., of Messrs. Vickers-Armstrongs, Ltd. (Companion).

PAPERS FOR WORLD ENGINEERING CONGRESS, TOKYO.

Authors.	*Titles.*
Mr. W. O. Manning, F.R.Ae.S. ...	"The Development of the Flying Boat in Great Britain."
Mr. A. H. R. Fedden, F.R.Ae.S. ...	"The Use of Air-Cooled Engines for Civil Aircraft."
Squadron Leader E. L. Johnston, O.B.E., A.F.C.	"Air Navigation from the Practical Point of View."
Dr. G. V. Lachmann, A.F.R.Ae.S. ...	"The Development of the Automatic Slot for the Control of Aircraft."
Mr. J. D. Siddeley, C.B.E., F.R.Ae.S.	"The Design, Production and Use of Steel Aircraft."
Major G. E. Woods-Humphery ...	"An Air Route Linking up the Occident with the Orient."
Mr. H. Davies, B.A., A.F.R.Ae.S. ...	"Monoplane *v.* Biplane."
Captain C. E. Ward	"Aerodrome Lighting."

After thanking the Staff and Honorary Officials for their services a short account of the financial position of the Society was given.

The Council's Report for the year 1928-1929, and the Balance Sheet and Income and Expenditure Account, as published in the March issue of the Journal, were adopted.

Messrs. Price, Waterhouse and Co. were re-elected Auditors for the ensuing year.

Mr. R. S. Capon, Mr. G. Merton and Flight Lieut. R. C. Preston were appointed scrutineers of the ballot for the election of the new members to the Council. As a result of the ballot the following members were declared elected to serve on the Council for the years 1929-1931 :—Air Vice-Marshal Sir Vyell Vyvyan, Major T. M. Barlow, Mr. R. Blackburn, Mr. Griffith Brewer, Wing Commander T. R. Cave-Browne-Cave, Mr. W. O. Manning, Major R. H. Mayo, Mr. T. O. M. Sopwith, Mr. C. C. Walker and Mr. H. E. Wimperis.

A vote of thanks was accorded to the Chairman and the Scrutineers for their services, and the meeting closed.

Elections to Council

As a result of the ballot for election the following is the Council for the year 1929-1930 :—

President.

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S.

Past-President.

Air Vice-Marshal Sir W. Sefton Brancker, K.C.B., A.F.C., F.R.Ae.S.

Vice-Presidents.

Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O.
Lieut.-Colonel J. T. C. Moore-Brabazon, M.C., F.R.Ae.S., M.I.Ae.E., M.P.

Council.

Captain P. D. Acland.
Major T. M. Barlow, M.Sc. (Eng.), M.Inst.C.E. M.I.Mech.E., F.R.Ae.S.
Mr. Robert Blackburn, F.R.Ae.S.
Mr. M. L. Bramson, A.C.G.I., A.F.R.Ae.S., M.I.Ae.E.
Mr. Griffith Brewer, F.R.Ae.S.
Major J. S. Buchanan, O.B.E., A.M.I.Mech.E., F.R.Ae.S.
Wing Commander T. R. Cave-Browne-Cave, C.B.E., A.M.I.Mech.E., A.M.I.N.A., F.R.Ae.S.
Captain F. T. Hill, F.R.Ae.S., M.I.Ae.E., B.Sc., Wh. Ex.
Captain A. G. Lamplugh, A.F.R.Ae.S.. M.I.Ae.E.
Major A. R. Low, F.R.Ae.S.
Mr. W. O. Manning, F.R.Ae.S.
Major R. H. Mayo, O.B.E., F.R.Ae.S.
Mr. F. Handley Page, C.B.E., F.R.Ae.S.
Mr. T. O. M. Sopwith, C.B.E., F.R.Ae.S.
Mr. C. C. Walker, Assoc.M.Inst.C.E., F.R.Ae.S.
Mr. H. E. Wimperis, O.B.E., F.R.Ae.S.
Mr. L. A. Wingfield, M.C., D.F.C.. A.R.Ae.S.I.
Mr. R. McMinnon Wood, M.B.E., A.M.Inst.C.E., F.R.Ae.S.

Hon. Treasurer: Major D. H. Kennedy, O.B.E., F.R.Ae.S.

Hon. Librarian: Mr. J. E. Hodgson.

Hon. Accountant: Mr. A. N. D. Smith, F.I.C.A.

Council Meeting

A meeting of Council was held on Tuesday, March 19th. Present: Colonel the Master of Sempill, President, in the chair.

Captain P. D. Acland
Mr. M. L. Bramson
Mr. Griffith Brewer
Wing-Cmdr. T. R. Cave-Browne-Cave
Mr. C. R. Fairey
Mr. F. T. Hill
Maj. D. H. Kennedy (*Hon. Treasurer*)
Captain A. G. Lamplugh
Major A. R. Low
Mr. W. O. Manning
Lt.-Col. M. O'Gorman
Mr. T. O. M. Sopwith
Mr. L. A. Wingfield (*Hon. Solicitor*)

Among the items on the Agenda which were considered were the arrangements for the International Aircraft Show at Olympia; the Wilbur Wright Memorial Lecture; the subject of the Elliott Memorial Prize; the report of the Grading Committee; the report of the Financial Committee; and the report of the Royal Aero Club's Committee on Early Flights.

Finance Committee

A meeting of the Finance Committee was held on Tuesday, March 12th, 1929. Present:—

Major D. H. Kennedy, in the Chair.
Mr. H. T. Tizard.
Mr. L. A. Wingfield.
Mr. J. E. Hodgson.

Among the items on the Agenda which were considered were the possibilities of obtaining a building to house a number of institutions and societies doing work analogous to that of the Royal Aeronautical Society; draft deeds of various trust funds administered by the Society; and the approval of cheques to be signed.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Tuesday, March 19th, 1929:—

Associate Fellows.—Sydney Brew, John Adrian Chamier, Harold Henry Holmes, Gustav Victor Lachmann, John Watson Maccoll (from Student), Norman McCrirrick, Norman MacMillan, Reginald John Penn, John Henry Powle (from Student), Alfred Drummond Warrington-Morris.

Associate Members.—Arthur George Adams, Gervase Balfour Bennett, Joseph George Navarro.

Associates.—Carlos Manuel Gadda, Earl McNabb Hand, Seymour Cunningham Redshaw, Arthur Richard Seabrook.

Students.—Henry Robert Free, Earl Hoey, Geoffrey John Eliot Howard, Edward Johnstone Langan, Michael Longridge, Kenneth Wilson Marshall, William Richard Massey, Clifford Mapp, Errol William Seymour-Hosley.

Companions.—Carl de Ganahl, Marcos A. Zar, St. John Tempé Plevins.

Elliott Memorial Prize

The subject for the Elliott Memorial Prize Essay this year has been decided upon, by the Council, as follows:—

"The contribution of Mechanical Skill to the work of the Royal Air Force."

The prize is open only to apprentices at Halton, and the closing date is June 30th, 1929.

Branches

COVENTRY BRANCH.

A very successful visit was arranged on March 16th to Cardington to inspect R.101. Over 300 members and their friends made the journey to Cardington.

Forthcoming Arrangements

April 4th.—Major G. H. Scott, A.F.C., D.S.O., F.R.Ae.S., will lecture on "The Mooring and Handling of large Airships" in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

April 11th.—M. Lapresle, Director of the Eiffel Laboratory, will lecture on "French Wind Tunnel Methods" in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

April 18th.—Colonel V. C. Richmond, O.B.E., A.F.R.Ae.S., will lecture on "R.101" in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

April 25th.—Squadron-Leader C. L. Scott, D.S.C., will lecture on "By Flying Boat to India" in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

J. LAURENCE PRITCHARD, *Secretary*.

OBITUARY

M. A. S. Riach

By the death of M. A. S. Riach the Society has lost one of its most brilliant Fellows. Mr. Riach was handicapped for many years by illness, and unable to leave such a mark on aviation which he otherwise undoubtedly would have done.

Mr. Riach was the eldest son of Colonel M. S. Riach, and was educated at Wellington College and the Armstrong Engineering College, Newcastle-on-Tyne. From his earliest days he took a great interest in aeronautics. After a short course at the London Polytechnic he was apprenticed to the late Mr. Holt Thomas and prior to and during the War he was concerned with the design of propellers with Mr. Grahame White. Afterwards, at the Air Ministry, he was concerned with Mr. Louis Brennan in the design of the latter's helicopter. Mr. Riach published many papers on airscrews and a book on the subject in 1916. Mr. Riach was one of the youngest Fellows of the Society, to which grade he was elected in 1917.

Katharine Wright Haskell

> "WRIGHT HASKELL. On Sunday, March 3, 1929, from pneumonia, at Kansas City, Katharine Wright Haskell, wife of Harry Haskell, only daughter of the late Bishop Milton Wright and sister of Wilbur and Orville Wright. Funeral at Dayton, Ohio, to-day (Wednesday)."

The above notice appeared in the "Times" on the 6th March and seems to have passed unnoticed. It is sad to think that human memory is so short that twenty years can obliterate the memory of some of our best friends. Yet, twenty years ago, Katharine Wright accompanied her brothers, Wilbur and Orville Wright, through France, Italy, Germany and England, in the first demonstration in Europe of actual flying. During that time she met King Edward, King Alphonso, and the leading Presidents and people on this side of the Atlantic, and her charm made her fast friends with many people in this country. She did not forget her friendship for England; for, on the 6th June, 1916, Lord Northcliffe, in speaking before the Royal Aeronautical Society before America had come to our assistance in the Great War, quoted a letter he had received from Katharine Wright, in which she said: "We here make no pretence at being neutral—we are heart and soul for England and her Allies in this great struggle." Members of the Society will remember that it was after this that Lord Northcliffe went to America, and by his eloquence and earnestness played such a valuable part in securing the wholehearted co-operation of America in the European struggle for freedom.

We have, therefore, not merely to remember Katharine Wright for the encouragement and help which she gave to her brothers at a time when sympathy and comfort were most required in the attainment of flight; but we, as a nation, have to remember her with grateful feelings for the part which she contributed in securing the co-operation of an ally of overwhelming power, at the time when our very existence was in peril.

G. B.

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

MAY, 1929

Visit to R.101

Provisional arrangements are in hand for a visit to Cardington by members of the Society. The date at present arranged is May 25th. Will those members who wish to take part write in *at once* to the Secretary, so that some idea of the numbers can be obtained. No application can be considered after May 18th. Full particulars of arrangements will be sent to those participating.

Schneider Trophy Race

The Royal Aero Club has entered into an arrangement with the Orient Steam Navigation Company for the s.s. "Orford," 20,000 tons, to be the official ship of the Club for the accommodation of the members and their friends, including those of kindred Societies and associated Light Aeroplane Clubs. The ship will be moored on the starting and finishing line off Ryde Pier.

Fares (including food and accommodation, but excluding wines, etc.) for the period from Friday evening, the 6th September, until Sunday evening, the 8th September, range from 7 guineas to 25 guineas per berth.

The arrangement with the Orient Line is such that members wishing to secure accommodation for themselves and their friends must take over their bookings *not later than Friday, May 10th.*

All inquiries respecting berths must be made direct to the Managers of the Orient Line, Anderson, Green and Co., Ltd., 5, Fenchurch Avenue, London, E.C.3; 14, Cockspur Street, London, S.W.1; or 1, Australia House, Strand, W.C.2.

Subscriptions

The attention of members is drawn to Rules 67, 70 and 73, which read as follows:—

RULE 67.—All Annual Subscriptions are due on the First of January in each year for the year then commencing.

RULE 70.—Any Fellow, Member, Associate Fellow, Associate Member, Associate, Student, Companion or Founder Member, whose subscription shall not have been paid before the First day of April, shall be in arrears of subscription and shall not be entitled to attend or vote at any meeting or to receive any publications to which he would be otherwise entitled.

RULE 73.—Every person whose subscription is two years in arrear, that is to say, whose arrears and current subscription shall not have been paid on or before the First of April, shall be reported to the Council, who shall direct application to be made to him according

to Form K in the Appendix hereto; and in the event of its becoming one additional month in arrear, after such application, the Council shall have the power, after suitable remonstrance by letter in the form so provided (Form L), of expelling the defaulter from the R.Ae.S.I., by erasing his name from the register or lists of the R.Ae.S.I., but he shall remain liable for the monies due.

Council Meeting

A meeting of Council was held on Tuesday, April 16th, 1929, in the Offices of the Society. Present:—

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., *President*, in the chair.

Captain P. D. Acland.
Major T. M. Barlow, F.R.Ae.S.
Mr. M. L. Bramson, F.R.Ae.S., M.I.Ae.E.
Mr. Griffith Brewer, F.R.Ae.S.
Mr. F. T. Hill, F.R.Ae.S., M.I.Ae.E.
Mr. J. E. Hodgson (*Hon. Librarian*).
Major D. H. Kennedy, F.R.Ae.S. (*Hon. Treasurer*).
Captain A. G. Lamplugh, A.F.R.Ae.S., M.I.Ae.E.
Mr. W. O. Manning, F.R.Ae.S., M.I.Ae.E.
Major R. H. Mayo, F.R.Ae.S.
L.-Col. J. T. C. Moore-Brabazon, (*Vice-President*), F.R.Ae.S., M.I.Ae.E., M.P.
Mr. F. Handley Page, F.R.Ae.S.
Mr. T. O. M. Sopwith, F.R.Ae.S.
Mr. C. C. Walker, F.R.Ae.S.
Mr. L. A. Wingfield, A.R.Ae.S.I. (*Hon. Solicitor*).
Mr. R. McKinnon Wood, F.R.Ae.S.

Among the items on the agenda which were considered were the following:—The preparations and plans for the Society's exhibit at the forthcoming International Aircraft Exhibition at Olympia, July 6th—16th; the report of the Grading Committee; the report of the Finance Committee; consideration of action to be taken to obtain a suitable building to house the Society and kindred bodies under one roof; and the appointment of the various Committees of Council for 1929-30.

The following resolution was unanimously passed:—

> "That the Council wish to express their very deep appreciation of the valuable services rendered by Mr. C. R. Fairey during the years he has been on the Council. The Council are particularly mindful of the fact that Mr. Fairey was instrumental in the first instance in obtaining the financial support of the S.B.A.C. It is their earnest wish that the Council may be able to call on Mr. Fairey on occasions of very special importance."

Committees of Council

The following are the Committees of Council for the year 1929-30:—

GRADING COMMITTEE.

Mr. R. Bruce.
Captain Barnwell.
Major F. A. Bumpus.
Captain F. T. Hill.
Dr. H. C. Watts.
Major A. R. Low.
Prof. B. Melvill Jones.
Mr. P. A. Ralli.
Major F. M. Green.
Captain G. S. Wilkinson.
Colonel L. F. R. Fell.
Mr. W. P. Savage.
Mr. R. V. Southwell.
Mr. A. Gouge.
Mr. R. J. Mitchell.
Mr. E. F. Relf.
Mr. J. D. North.

FINANCE COMMITTEE.

Major D. H. Kennedy.
Mr. J. E. Hodgson.
Mr. A. N. D. Smith.
Mr. L. A. Wingfield.
Mr. C. R. Fairey.
Mr. F. R. Simms.
Captain F. T. Hill.

INFORMAL DISCUSSIONS COMMITTEE.

Mr. M. L. Bramson.
Major J. S. Buchanan.
Mr. F. A. Foord.
Major R. H. Mayo.

MEDALS AND AWARDS COMMITTEE.

Mr. Griffith Brewer.
Major J. S. Buchanan.
Major T. M. Barlow.
Mr. A. H. R. Fedden.
Wing Cmdr. G. B. Hynes.
Mr. W. O. Manning.
Mr. C. C. Walker.
Mr. G. R. Volkert.
Sir Alliott Roe.
Mr. L. A. Wingfield.
Mr. R. McKinnon Wood

JOINT STANDING COMMITTEE WITH THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS AND THE ROYAL AERO CLUB.

Mr. Griffith Brewer.
Colonel the Master of Sempill.
Air Vice-Marshal Sir Vyell Vyvyan.

LECTURE SUB-COMMITTEE.

Major J. S. Buchanan.
Major T. M. Barlow.
Mr. Robert Blackburn.
Mr. A. E. L. Chorlton.
Mr. F. T. Hill.
Major A. R. Low.
Mr. W. O. Manning.
Captain J. Laurence Pritchard.
Colonel the Master of Sempill.

REPRESENTATIVES ON OTHER BODIES.

British Engineering Standards Association Aircraft Committee.—Major R. H. Mayo and Dr. H. C. Watts.

Central Library for Students.—Mr. J. E. Hodgson.

Students' Section.—Mr. T. Tanner (Honorary Secretary).

Association of Special Libraries and Information Bureau.—Mr. J. E. Hodgson (Hon. Librarian).

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Tuesday, April 16th, 1929:—

Associate Fellows.—Harry Bateman, Basil Binyon, Harry Edgar Broadsmith (re-elected), George Burrell Fenton (transferred from Student).

Associate Member.—George Neville Bradley Richards.

Associates.—Charles Neville Colson, Donald Vernon Irvins.

Student.—James Purkis Smith.

Busk Studentship

A vacancy has arisen for the Busk Studentship in Aeronautics for the year 1929-30.

The studentship was established in memory of E. T. Busk, who in 1914 lost his life while flying an experimental aeroplane. The Studentship is of the value of about £130, tenable for one year from October 1st; but a student may be re-appointed on the same terms for a second year. It is open to any man or woman, being a British subject and of British descent, who has not attained the age of 25 years on October 1st next. Forms of application for the Studentship can be obtained from

Professor B. MELVILL JONES,
Engineering Laboratory,
Cambridge,

and must be filled up and returned to him not later than May 12th next.

Gordon Bennett Trophy Race

The third Gordon Bennett Trophy Race for Balloons will be competed for at St. Louis, Missouri, September 28th, 1929. Entries must reach the National Aeronautic Association, 910, 17th Street, N.W., Washington, D.C., before June 28th, 1929, from whom full particulars may be obtained.

Hague International Air Congress

The 5th International Air Congress will be held at the Hague, Holland, from September 1st—6th, 1930. The Congress will be held under the auspices of the Royal Government of the Netherlands and the actual organisation will be in the hands of the Royal Aero Club of the Netherlands.

Papers for the Congress should be written in French or, if in another language, be accompanied by a French translation. Papers must be sent in by March 31st, 1930.

Akroyd Stuart Prize

The date given for the closing of entries for the Akroyd Stuart Prize given in the March Monthly Notices should be June 30th, 1930, and the years for which the prize is awarded should read 1928-1930. The prize, which is of the value of approximately £68, is awarded for the best paper on the subject of "The Origin and Development of Heavy Oil Aero Engines."

Branches

The following report has been received from the Yeovil Branch of the Society:—

GENERAL REPORT AT CLOSE OF 1928-9 WINTER SESSION (APRIL, 1929).

(1) *Branch Formed*, October, 1926.

(2) *Number of Members*—

October, 1927	117
October, 1928	177
April, 1929	242

(3) *Activities during 1928-9 Session to Date*—

(*a*) Number of events programmed to date, 24.
(*b*) Number of events so far held, 22 (comprising 18 lectures, two film displays, four works visits).
(*c*) Average attendance at above, 74 members.

(4) *Coming Events.*

(*a*) Visit to the Marconi Wireless Station at Somerton.
(*b*) Visit to Gloving Manufactory, Yeovil.
(*c*) Visit to Newspaper Printing Works.
(*d*) Outing to R.A.F. Display, Hendon.
(*e*) Visit to Aero Show at Olympia.
(*f*) Outing to Schneider Cup Race.
(*g*) Conducted Tour of Petter Engine Works and Foundry.

Further fixtures before the branches are given in Forthcoming Events.

Lantern Slides

The Council wish gratefully to acknowledge seventeen lantern slides illustrating the Automatic Slot and Interceptor Control, from Messrs. Handley Page, Ltd.

The Society has a large and rapidly growing collection of slides which are available, under certain conditions, for members to borrow for the purpose of giving lectures, etc.

Forthcoming Arrangements

May 6th.—Air Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., will lecture at 8.30 before the Oxford Branch.

May 9th.—Captain F. Tymms, M.C., A.F.R.Ae.S., will lecture on "Civil Aviation Prospects in East Africa," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

May 16th.—Dr. E. G. Richardson will lecture on "Recent Model Experiments in Aerodynamics" before the Bristol Branch, at 8 p.m.

May 23rd.—Mr. F. A. Foord, A.F.R.Ae.S., will lecture on "Lubrication of Aircraft Engines," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

OBITUARY

Lieut.-Colonel Sir Alan Burgoyne

It is with great regret that the Council have received news of the death of Sir Alan Burgoyne, M.P. Sir Alan joined the Society in 1917, and was a Member of Council from 1918-1920.

Sir Alan Burgoyne, who was born on September 30th, 1880, was a man of wide interests and took a particular interest in the Navy and the Air Force. For some years he was Hon. Treasurer of the Navy League and founded and edited the *Naval League Annual*. From 1916-1918 he was Hon. Secretary of the Parliamentary Air Committee, and Treasurer 1919-20.

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

JUNE, 1929

Conversazione

The International Aero Exhibition will take place at Olympia from July 16th-27th. The Royal Aeronautical Society have arranged to hold a Conversazione on the evening of Thursday, July 25th, in the Science Museum, South Kensington, by kind permission of Colonel Sir Henry Lyons. The date chosen is the twentieth anniversary of the first aeroplane flight across the English Channel, and it is hoped that with the kind assistance of the French Authorities the original machine on which M. Bleriot made the historic flight will be on loan at the Science Museum for the evening.

The Wilbur Wright Memorial Lecture will be delivered during the evening by the Hon. Wm. McCracken, Jnr., Assistant Secretary of State for Commerce of the National Advisory Committee for Aeronautics of the United States of America. The lecture is entitled, "Science in its Relation to Regulating and Promoting Civil Aviation."

The approximate programme for the evening will be:—

7.15—8.15 p.m. Council Dinner.
8.30—9.0 p.m. Reception by the President and Council at the Science Museum.
9.0 —9.45 p.m. The Wilbur Wright Memorial Lecture.

The Council very much hope that members and others will keep this date free so that they may have the pleasure of their company at the Reception and Lecture.

International Aero Exhibition, Olympia

The Society are organising the non-commercial side of the International Aero Exhibition to be held at Olympia, July 16th-27th next. This side of the Exhibition comprises the Historical and Scientific Section, the programme of lectures and cinematograph films, and the arrangements for educational visits by parties of school children.

Arrangements are well in hand in connection with the exhibit of the Society. The exhibit, which will be on the same general lines as that shown at the Berlin Exhibition last October, will be arranged by Mr. J. E. Hodgson, the Honorary Librarian. It will include drawings, photographs, prints, rare books and pamphlets, and manuscrips, showing the gradual evolution of the idea and the practice of flight in Great Britain from the earliest down to recent times. From the British technical standpoint no more interesting and illustrative collection, arranged as far as possible in chronological order, has ever been displayed. Mr. Hodgson, who is well known as one of the leading authorities in aviation history, has agreed to lend a large number of valuable books and prints from his own collection.

The Society's exhibit will be shown in the Gallery in conjunction with that of the Air Ministry. Arrangements have also been made for the Society to have an office and telephone next to their exhibit and also a stand where any of its publications may be obtained or any information given.

The Royal Aeronautical Society are helping to arrange for exhibits near to and similar to their own by corresponding bodies on the Continent. Among other countries which will be represented by historical and scientific exhibits are France and Italy.

The Council express the hope that every member of the Society will make a special point of seeing the Society's exhibit, and encourage others to do so.

During the run of the Exhibition a number of lectures under the ægis of the Society will be read by British and Foreign authorities on the progress of aviation in their respective countries, and in the cinema hall films of aeronautical educational and historical interest will be shown.

Council Meeting

A Meeting of Council was held on Wednesday, May 15th, 1929, in the Offices of the Society. Present:—

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., President, in the Chair.

Captain P. D. Acland.
Major T. M. Barlow.
Mr. R. Blackburn.
Sir Sefton Brancker (Vice-President).
Mr. Griffith Brewer.
Major J. S. Buchanan.
Wing-Com. T. R. Cave-Browne-Cave.
Mr. F. T. Hill.
Major D. H. Kennedy (Hon. Treasurer)
Captain A. G. Lamplugh.
Mr. W. O. Manning.
Major R. H. Mayo.
Mr. L. A. Wingfield (Hon. Solicitor).

Among the items on the agenda which were considered were the following:—The preparations and plans for the Society's exhibit at the forthcoming International Aero Exhibition at Olympia, July 16th-27th; the arrangements for the Conversazione to be held at the Science Museum on Thursday, July 25th, the twentieth anniversary of the first cross-Channel flight; the election of the President and Vice-Presidents for the year 1929-1930; the report of the Finance Committee; the report of the Grading Committee; the report of the Joint Building Committee, and the arrangements for the visit to R.101 at Cardington.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Wednesday, May 15th, 1929:—

Fellows (from Associate Fellows).—James Bird, Edward Featherstone Briggs, Leopold William Bryant, Alan Ernest Leofric Chorlton, Robert Alexander Frazer, Norman Augustus Victor Piercy, David Randall Pye, George Shakespeare Wilkinson.

Associate Fellow.—Francis William Musson.

Associates.—Colin Layzell Apps, Richard Bernard Brigham, Sidney Charles Ilett, Frederic Pilling, George Tom Willey.

Students.—Walter Stuart Coleman, John Freeman Cuss, Anthony Christopher Loraine Rendel, William David Sherriff, Thomas Horsfall Wood.

Companions.—Joseph Russell Knowles, Joseph Dawson Paul, Junichiro Yamashita.

Second International Light Aeroplane Meeting

The Second International Light Aeroplane Meeting, organised by the Rotterdam Aero Club, will be held from June 27th-30th. Full particulars may be obtained from the Secretary, Rotterdam Aero Club, Veerdom I, Rotterdam, and all entries must be received before June 20th.

Slides Received

The Council gratefully acknowledge the gift of seventeen lantern slides from Messrs. Handley Page Ltd., illustrating the Automatic Slot and Interceptor Control.

Thanks to the generosity of many firms and of individuals, the Society's collection of lantern slides is now a large and representative one. Members may borrow slides for the purposes of lectures, and a list of slides is available for the purpose.

Obituary

The Council record with great regret the deaths of Mr. H. G. Locell, who was a Founder-Member of the Society, and one of its most enthusiastic supporters; and of Captain King Paton, who was elected an Associate Fellow in 1919.

Visit to Cardington

On Saturday, May 25th, a visit was paid to the Royal Airship Works at Cardington to see H.M. Airship R101. The visit was attended by some three hundred members and friends, and proved to be one of the most interesting and enjoyable ever arranged by the Society. It was not found practicable to allow more than one hundred members over the ship itself, but all were admitted to the works and were able to see the ship from the ground.

The Council wish to place on record their grateful thanks to those at the Royal Airship Works who did so much to make the visit so successful, and particularly to Group-Captain F. M. Fellowes, D.S.O., Director of Airship Development, Lieut.-Col. V. C. Richmond, O.B.E., Wing-Commander T. R. Cave-Browne-Cave, C.B.E., who had general charge of the arrangements, and to the following, who acted as volunteer guides :—Squadron-Leader F. M. Rope, Flying Officer Fitzgerald, Flying Officer Cook, Mr. Collins, Mr. McWade, Mr. Dyer, Mr. Pugsley, Mr. Rayner, Mr. Eldridge, Mr. Randle, Mr. Uren, Mr. Hayes, Mr. Brook, Mr. Hogg, Mr. Harris, Mr. Taylor, Mr. Thompson, and Mr. Weston. The members and guests were received by the President, Colonel the Master of Sempill, assisted by the Hon. Mrs. Forbes Sempill.

J. Laurence Pritchard, *Secretary.*

OBITUARY

Richard Elwood Bissell

A victim of the Cleveland Clinic disaster which took a toll of over one hundred lives, Richard Elwood Bissell, chief engineer of Thompson Products, Inc., Cleveland, died suddenly May 15th, 1929, at the age of 37 years.

Richard Elwood Bissell was born at Milford, Michigan, September 4th, 1892, and graduated with a degree of Bachelor of Science in 1913. The following year he received a Master of Science degree from the University of Michigan. In 1927 an honorary degree in metallurgical engineering was conferred upon him by Michigan State College in recognition of contributions he had made to automobile progress. He went with Thompson Products, Inc. ten years ago as head of the metallurgical department, and was made chief engineer last October.

Bissell was a member of the Society of Automotive Engineers, and an Associate of the Society. The Council feel that by his death the Society has lost one of its most brilliant members.

THE
ROYAL AERONAUTICAL SOCIETY
With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES
JULY 1929

International Aero Show

The Royal Aeronautical Society will be represented at the International Aero Show, July 16th-27th, by a remarkable historical exhibit showing the gradual evolution of the idea and practice of flight in Great Britain from the earliest down to recent times.

The exhibit, which will be located in the New Gallery alongside that of the Air Ministry, who will carry on the story of the air from 1914 onwards, will include drawings, photographs, prints, rare books and pamphlets, and manuscripts, arranged in chronological order. The books, MSS. and smaller engravings are contained in show cases, while the engravings and drawings displayed on the walls will afford a pictorial history from the invention of the balloon in 1783 down to recent times. The exhibit is divided broadly into the following sections:—

(1) Early Ideas of Flight, B.C. 300—A.D. 1780.
(2) The Invention of the Balloon, 1783.
(3) James Sadler (1751-1828), the First English Aeronaut.
(4) Sir George Cayley (1773-1855), the Father of Aeronautical Science.
(5) Charles Green (1785-1870), Famous Victorian Balloonist.
(6) W. S. Henson and John Stringfellow (1840-1868).
(7) The Royal Aeronautical Society, Founded 1866.
The foundation of the Society may be said to mark the beginnings of Aeronautical Science in this country. This section is represented by many of the early proceedings of the Society, autograph letters, and documents from the Society's archives.
(8) The Development of the Airship.
(9) Percy Pilcher and Lawrence Hargrave.
(10) Pioneers of the Aeroplane, 1908-1914.
(11) The Development of the Parachute.
(12) Caricatures and Curiosities of Flight.

Among the interesting exhibits which are shown by the Society are the log book of the R.34, Sir Hiram Maxim's own corrected proof sheets of his *Natural and Artificial Flight*, autograph letters from Cayley, Chanute, Pilcher, Weiss, Wilbur Wright, and many others, the Minute Book of the Council of the Society from 1866-1909, etc. Altogether the Society's exhibit will comprise somewhere upwards of 600 separate items. Mr. Hodgson, the Honorary Librarian of the Society, who is arranging the exhibit, has agreed to lend a large number of valuable books and prints from his own collection, while members of the Society have readily come forward to lend relics and other objects to make the exhibit the most complete and representative which has ever been gathered together.

The Stand numbers of the Society's exhibit are 222-229 inclusive. The Society will have an office and a telephone, and it is the express wish of the Council that all members visiting Olympia will make use of any facilities the Society can offer in the way of obtaining information, and so on. Officials of the Society will be on duty at the Society's exhibit during the whole of the Exhibition. It is specially hoped that those who live in the provinces, and foreign members visiting the Show, will make a point of calling at the Society's Stand. The Society's telephone number at Olympia will be "Riverside 5526."

An extensively illustrated souvenir of the Society's exhibit is in preparation and will be on sale at a nominal charge on the Society's Stand. The souvenir will also contain a history of the Society and an account of the pioneer work which was carried out by its members between 1866 and 1914.

INVENTIONS SECTION.

A portion of the accommodation allotted to the Society has been set aside for the exhibition of inventions relating to aeronautics which have not yet reached the point of commercial development. A number of interesting entries for this section have been received.

FOREIGN HISTORICAL EXHIBITS.

Under the ægis of the Society historical exhibits will be shown by:—

France (Stand No. 226).—Service Technique de l'Aeronautique.

Germany (Stand No. 228 and 229).—Aerodynamischen Versuchanstalt, Göttingen; Wissenschaftliche Gesellschaft fur Luftfahrt.

Italy (Stands Nos. 224-225).—Associazione Italiana di Aerotecnica.

CINEMA, EXHIBITIONS AND LECTURES.

During the Exhibition series of lectures will be given by the leading authorities of the following countries:—Canada, France, Great Britain, Italy, Holland, Sweden, and United States of America, outlining the progress of aviation in their country during the past few years. The lectures will be delivered between 12 and 1 p.m. in the Cinema Hall of the Exhibition.

LECTURES WILL BE GIVEN BY THE FOLLOWING:—

France.—M. Franck, Chief of the Navigation Section of the Service Technique de l'Aeronautique, Paris: "Recent Progress of Aeronautical Science in France."

Great Britain.—A paper by an Air Ministry representative: "A Resumé of Aeronautical Research in Great Britain."

Canada.—Mr. W. F. Finlayson, Ontario Government Office, London: "The Application of Aircraft to Conditions in Ontario."

Holland.—Dr. ir H. J. v. d. Maas, Engineer-Pilot of the Rijks-Studiedienst voor de Luchtvaart, Amsterdam: "Some Points of General Interest from the Development of Aviation in Holland in the last Ten Years."

Italy.—(It is hoped to arrange for a lecture on Aeronautical Research in Italy.)

Sweden.—Mr. Tord Angstrom, Civil Engineer: "Aeronautical Research Work in Sweden."

U.S.A.—The Wilbur Wright Lecture will be given by the Hon. Wm. P. MacCracken, Jnr., Assistant Secretary of Commerce for Aeronautics and a member of the National Advisory Committee for Aeronautics of the U.S.A., entitled: "Science in its Relation to Regulating and Promoting Civil Aviation." The lecture will be delivered during the Conversazione on the evening of 25th July.

The Society are collaborating with the Air League of the British Empire in showing every day during the Exhibition aviation films of a popular, educational and technical nature. The Air Ministry, British and foreign firms, and private individuals are co-operating to make the Cinema films one of the most attractive exhibits at Olympia.

A machine has been lent by Celebritone, Ltd., so that films will be accompanied by appropriate sound effects.

SCHOOL CHILDREN.

The Society have made arrangements for parties of school children to visit Olympia on certain days and to be shown round the Exhibition. Education

authorities recognising the educational value of the Exhibition, have willingly collaborated with the Society in the arrangements, so that as many children as possible will be able to visit Olympia.

Conversazione

As announced in the June Monthly Notices arrangements have been made for the Society to hold a conversazione on the evening of Thursday, July 25th, in the Science Museum, South Kensington, by kind permission of Sir Henry Lyons. The date chosen is the twentieth anniversary of the first aeroplane flight across the English Channel, and with the kind assistance of the French authorities the original machine on which M. Blériot made the historic flight will be on view at the Science Museum for the evening.

The Wilbur Wright Memorial Lecture will be delivered during the evening by the Hon. Wm MacCracken, Jnr., Assistant Secretary of State for Commerce for Aeronautics and member of the National Advisory Committee for Aeronautics of the United States of America. The lecture is entitled, "Science in its Relation to Regulating and Promoting Civil Aviation." The lecture will be preceded by a Council dinner.

Arrangements have been made for light refreshments to be served at the Science Museum, and those who wish to may also buy alcoholic refreshment.

Approximately the times of the programme for the evening are:—

7.0—8.15 p.m.—Council Dinner.
8.30—9.0 p.m.—Reception by the President and Council of members and their friends and guests.
9.15—10 p.m.—The Wilbur Wright Memorial Lecture.
10 p.m.—12 a.m.—Conversazione.

During the evening the Royal Air Force String Band will play.

The Council very much hope that members and others will keep the date free, so that they may have the pleasure of their company at the reception, lecture and conversazione.

The price of tickets (including light refreshments) is 5s. each, and early application is advisable. Full evening dress will be worn.

President

At a meeting of Council held on May 15th, 1929, Colonel The Master of Sempill, A.F.C., A.F.R.Ae.S., was re-elected President for 1929-30 under Rules 78 and 80.

The following is an extract from the Council minutes:—

"Having considered Rules 78 and 80 in conjunction with the previous records of the Society, the Council consider they are correct in accepting the nomination of Colonel the Master of Sempill for the Presidency."

Vice-Presidents

At a meeting of Council held on May 15th, 1929, Air Vice-Marshal Sir Vyell Vyvyan, Lieut.-Colonel J. T. C. Moore-Brabazon, and Mr. H. E. Wimperis were elected Vice-Presidents under Rule 84.

Council Meeting

A meeting of Council was held on Tuesday, June 11th, 1929, in the offices of the Society. Present:—

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President) in the Chair.

Captain P. D. Acland	Major A. R. Low
Mr. M. L. Bramson	Mr. W. D. Manning
Mr. Griffith Brewer	Mr. F. Handley Page
Major J. S. Buchanan	Mr. C. C. Walker
Mr. F. T. Hill	Mr. L. A. Wingfield (*Hon. Solicitor*)

Major D. H. Kennedy (*Hon. Treasurer*)

Among the items on the agenda which were considered were the following :— The preparations and plans for the Society's exhibit at the forthcoming International Aero Exhibition at Olympia, July 16th-27th; the arrangements for the conversazione to be held at the Science Museum on Thursday, July 25th, the twentieth anniversary of the first cross-Channel flight; the report of the Finance Committee; the report of the Grading Committee; and the report of the Lectures Committee.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Tuesday, June 11th, 1929 :—

Fellows (Re-graded from Associate Fellows).—Vincent Crane Richmond, Frederick Sigrist.

Associate Fellows.—Lester Durand Gardner, Henry Knowler (re-elected), Alan Sidney Lane.

Associate Members.—Reginald Collis, Anthony Frank Lago.

Associates.—Frank Rodney Baldwin, Alfed Carey Clinch.

Students.—Richard J. Jackson, Maurice Tudor Judson, Gerald Patrick King, Albert H. Lawrence, George Nelson, Robert Francis Rowe, A. I. Ryness, Alfred Lee Tyler, Leonard Ward, Leonard Seymour Werry, Clement Edgar Wood, Reginald Thomas Wood.

Companion.—Leonard S. Horner.

Society of Model Aeronautical Engineers

The Society of Model Aeronautical Engineers will be exhibiting at Stand 204 at the Olympia Aero Exhibition. The models which will be exhibited will comprise some of the latest ideas in model aeroplane design, and among them will be found a speed model, a model autogyro, a model of the pterodactyl or tailless aeroplane, and others apart from the more orthodox types. All the models are actual flying models, some of which hold British model records. Any particulars as to the flying competitions and general activities of the Society may be obtained by asking members who will be on duty at the Stand, or by applying to the Hon. Secretary, S. H. F. Crouch, 23, Mayfair Avenue, Ilford, Essex.

Civil Aviation Ball

A Civil Aviation Ball, under the auspices of the Air League of the British Empire, will be held at Grosvenor House, Park Lane, W.1, on Friday, July 19th, 1929. The price of tickets is 30/- each, including supper, and there will be dancing from 10 p.m. to 4 a.m. Application for tickets should be made to Lieut.-Colonel Thwaites, C.B.E., M.V.O., M.C., Air League of the British Empire, Astor House, Aldwych, W.C.2, or any of the usual agencies.

Forthcoming Events

July 13th.—R.A.F. Display, Hendon, 10 a.m.—6 p.m.

July 16th-27th.—Aero Exhibition at Olympia.

July 19th.—Civil Aviation Ball, Grosvenor House, Park Lane.

July 25th.—Wilbur Wright Memorial Lecture by the Hon. Wm. P. MacCracken, Jnr., Assistant Secretary of Commerce for Aeronautics and Member of the National Advisory Committee for Aeronautics of the U.S.A., on "Science in its Relation to Regulating and Promoting Civil Aviation." The lecture will be delivered in the Science Museum, South Kensington, at 9.15 p.m.

July 25th.—Reception and Conversazione at the South Kensington Museum by the President and Council, 8.30 p.m. to midnight.

J. LAURENCE PRITCHARD, *Secretary.*

THE
ROYAL AERONAUTICAL SOCIETY
With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES
AUGUST, 1929

Office Closing

The offices, 7, Albemarle Street, will be closed from August 1st to August 11th.

Annual Council Dinner

The Annual Council Dinner, preceding the Wilbur Wright Memorial Lecture, was held, by kind permission of Colonel Sir Henry Lyons, in the Science Museum, South Kensington, on Thursday, July 25th, 1929. The list of the Council present and their guests will be given when the Wilbur Wright Memorial Lecture is published.

International Aero Exhibition

The JOURNAL has to go to press before the closing day of the Exhibition, so that it is not possible to do more than sketch briefly the results of the Exhibition to the Society. A complete account will be published in a future number of the JOURNAL for permanent record.

The Society's exhibits, including the Historical, French, German, Italian, Swedish and Inventions Sections, attracted great interest. No such collection has ever before been brought together. In the Society's own historical exhibit a period of nearly 3000 years of man's attempt to fly was covered by means of prints and documents, photographs, MSS., etc.

The unique and remarkable character of the Society's exhibits proved of absorbing interest to a large number of very distinguished visitors. Among those who paid a visit to the Society's stands were H.R.H. the Prince of Wales and H.R.H. the Duke of York (patrons of the Society), H.H. Prince Purachatra of Siam, Commander Prince Shimadya of the Imperial Japanese Navy, Captain Kingsford Smith and Lieutenant G. P. Ulm of the Southern Cross, Mr. Finlayson (the Minister of Lands and Forests for the Government of Ontario, Canada), Louis Paulhan, and many other distinguished pilots and members of the Society.

A remarkable tribute to the value of the exhibits has been the interest shown in it by visitors from abroad.

An illustrated Souvenir booklet has been printed describing the Society's exhibit, and it is hoped that every member who did not obtain his copy at Olympia will buy one as a permanent record. The price is one shilling, or 1s. 3d. post free.

Conversazione

On Thursday, July 25th, 1929, the Royal Aeronautical Society celebrated the 20th anniversary of the crossing of the English Channel by M. Blériot by holding a Conversazione, preceded by the Annual Council Dinner, before the

reading of the Wilbur Wright Memorial Lecture by the Hon. William P. MacCracken, Jnr., Assistant Secretary of State for Commerce for Aeronautics of the United States of America. All three functions were held in the Science Museum, South Kensington, by kind permission of Colonel Sir Henry Lyons, Director of the Museum. A very large number of the Society's members and many distinguished guests were present. Members and guests were received by the President (Colonel the Master of Sempill) and the Hon. Mrs. Forbes-Sempill, assisted by the Council. During the evening, by kind permission of the Air Council, the band of H.M. Royal Air Force, conducted by Flight Lieutenant J. H. Amers, M.B.E., Director of Music, R.A.F., played selections. A full report of the Wilbur Wright Memorial Lecture will be given in a forthcoming issue of the JOURNAL, together with a list of guests who were present.

Medals and Awards

The following recommendations of the Medals and Awards Committee were approved by the Council at their meeting on Wednesday, July 10th, 1929:—

Sir Charles Wakefield Gold Medal.

Awarded to Mr. H. B. Irving, F.R.Ae.S., for his work in connection with slot and control.

Taylor Gold Medal.

Awarded to Professor B. Melvill Jones, A.F.C., M.A., F.R.Ae.S., for his paper on "The Streamline Aeroplane," delivered before the Society on January 10th, 1929.

Simms Gold Medal.

Awarded to Mr. H. Sutton, M.Sc., A.F.R.Ae.S., for his paper on "The Use of Light Alloys in Aircraft from the Point of View of Corrosion," delivered before the Society on October 18th, 1928.

Busk Memorial Prize.

Awarded to Mr. W. S. Farren, M.B.E., M.A., F.R.Ae.S., M.I.Ae.E., for his paper "Monoplane or Biplane?" delivered before the Society on January 21st, 1929.

Council Meeting

A Meeting of Council was held on Wednesday, July 10th, 1929, in the offices of the Society. Present:—

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President), in the chair.

Captain P. D. Acland.
Major T. M. Barlow.
Mr. M. L. Bramson.
Mr. Griffith Brewer.
Mr. J. E. Hodgson (*Hon. Librarian*).
Captain A. G. Lamplugh.
Major A. R. Low.
Lieut.-Col. J. T. C. Moore-Brabazon, (*Vice-President*).
Mr. H. E. Wimperis.
Mr. L. A. Wingfield (*Hon. Solicitor*).
Mr. R. McKinnon Wood.

Among the items on the agenda which were considered were the following:—Lecture programme for 1929-30; the report of the Finance Committee; the report of the Grading Committee; the recommendations of the Medals and Awards Committee; and the final arrangements for the Society's Exhibit at Olympia.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Wednesday, July 10th, 1929:—

Associate Fellows.—J. H. Crowe, Claudius William Pidcock.

Associates.—Vivian Gwilym Jones, Maurice Downer, John Collingwood Goldie.

Students.—Ronald George Buck, Richard E. Drake, Herbert Belton Sharman, Cyril Williamson.

Membership Badges

For those members of the Society who wish to have them, a badge has been prepared. The badge shows the symbols of the Society, the peregrine and balloon, in finely chased gilt on a blue enamel background, surrounded by a royal blue border on which appears "Royal Aeronautical Society, 1866." The price of these badges is 5/- or 5/3 post free.

Correction

In the July issue of the JOURNAL a number of figures were omitted from the reprint of Mr. J. L. Hodgson's paper on model propellers. These figures will be printed in the next issue, and will be embodied in the reprint of the paper on the Isacco Helicogyre now in the press.

J. L. PRITCHARD, *Secretary.*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

SEPTEMBER, 1929

International Aero Exhibition

A full account of the exhibit of the Society at the recent Exhibition at Olympia will be given in the October issue of the Journal. It will be illustrated with a certain number of photographs so that it will be a permanent record of the effort made on behalf of the Society.

Membership Badges

For those members of the Society who wish to have them, a badge has been prepared. The badge shows the symbols of the Society, the peregrine and balloon, in finely chased gilt on a blue enamel background, surrounded by a royal blue border on which appears the lettering, "Royal Aeronautical Society, 1866." The badges have been made with the greatest possible care so that they will always retain their original appearance, and it is hoped that members will wear them on all suitable occasions. The price is 5/-, or 5/3 post free.

Souvenir Booklet

An illustrated Souvenir Booklet has been printed describing the Society's Exhibit at Olympia, and giving a history of the Society. It is hoped that every member who did not obtain his copy at Olympia will buy one as a permanent record. The number available is limited and early application should be made as it will not be possible to reprint. The price is one shilling, or 1/3 post free.

Endowment Fund

The Council wish to place on record an extremely generous offer which has been made by Messrs. Gale and Polden to the Society to enable the Society to increase its Endowment Fund. Messrs. Gale and Polden are publishing in the new year a Civil Aviation Pocket Diary on lines similar to their well-known and successful Royal Air Force Diary. The new Civil Aviation Diary will contain as full a record as possible of aviation meetings, lectures, functions, and so on, of use to all who are taking an active interest in flying. It is probable that a certain number will be prepared with the Society's crest embossed upon the cover for the use of members of the Society. Messrs. Gale and Polden have most generously offered to give 15 per cent. of the profits from the sale of the diary to the Endowment Fund, which is now being raised, so that the Society may have its own building and lecture hall. It is anticipated by the publishers that the Endowment Fund will receive a substantial sum annually. Further particulars of the Diary will be given in a later issue.

List of Members

The list of members which has, for a number of years past, been published in October, will in future be published in January in order to conform with the Society's year. Those members who change their addresses between now and December 31st, or who wish to have any alteration to their titles made, should notify the Secretary of such changes as quickly as possible.

Journal Wanted

The Director of the New York Public Library has written to the Secretary to inquire if any member has a spare copy of the Journal for January, 1928, now out of print. Any member who has a copy for disposal is asked to write direct to the Director, New York Public Library, Fifth Avenue and 42nd Street, New York City.

Correction

In Mr. North's remarks in the discussion of Colonel Richmond's paper "R.101," in the August Journal, Mr. North was quoted as saying that he did not think that measurement to within an accuracy of 0.030 inches in 45 feet was possible. This should read "impossible."

Abstracts

In the Abstracts from the Scientific and Technical Press, published in the June Journal, E. Offermann was given as the author, on page 475, of Riesenflugzeuge. The three parts of the book were written by three different authors, as stated in the preface, and the particular part abstracted was written by Alfred Richard Weyl.

Donation to the Library

The Council gratefully acknowledge a gift of the following books to the Library by Wing Commander Hubbard:—

"Gnome" Mono. Instruction Book No. 2.

Air Publication 129. Flying Training Manual. Part I., Flying Instruction. 1920.

Les Moteurs Gnome. Description Conduite Entretien. 1911.

Royal Air Force Flying Training. Part II., Applied Flying. December, 1922. Air Publication 928.

Handbook of the Renault Engine. 1913.

The Gnome Engine. Its Care, Maintenance and Use. By Major J. D B. Fulton. 1913.

J. LAURENCE PRITCHARD, *Secretary*.

OBITUARY

The Council have heard with great regret of the death of the following members of the Society :—

Pilot Officer Walter Patrick Dillon Bennett, Wing Comdr. John Dunville, Lord Edward Grosvenor, and Dr. T. Blackwood Murray.

Pilot Officer W. P. D. Bennett, who became a Student Member of the Society in February, 1929, died as the result of an accident near Boreham Wood, Hertfordshire, to a D.H.60. Pilot Officer Bennett was on the Reserve of Air Force Officers and at the time of the accident he was the sole occupant of the machine.

Wing Comdr. John Dunville, C.B.E., R.A.F., who was a Founder Member of the Society, died on June 10th, 1929. Wing Commander Dunville will always be remembered by a very wide circle of friends for his enthusiastic and practical support of aviation during its pioneering days. He made his first flight in a balloon in 1906 with the late the Hon. Charles Rolls, and from then onwards was a ballooning enthusiast. Two years after his first ascent he made a record for duration for a British balloon in the Gordon Bennett Race, remaining in the air 36 hours 56 minutes, and twice he won the challenge cup offered by the late Lord Northcliffe for the British balloon covering the longest distance in the year.

An early member of the Royal Aero Club, Mr. Dunville, as he was then, became keenly interested in the development of the aeroplane and was very actively engaged on the committee of the Club organising meetings. On the outbreak of war his wide ballooning experience was made use of in the Royal Naval Air Service, for training officers for balloon and airship work. He was made an Hon. Wing Commander, R.A.F., in 1926.

By the death of Squadron Leader Lord Edward Grosvenor, at the early age of 37, aviation has lost one of its most engaging personalities. It is a commentary in itself on the youthfulness of aviation that a man so young as Lord Edward Grosvenor can be regarded as one of the pioneers of the air. There is a framed photograph in the Secretary's room at the Society's office, the legend underneath reading, " No. 1 (Airship) Squadron, Royal Flying Corps, Military Wing, Army Manœuvres, 1913." Two of the centre figures in the group are Major E. M. Maitland and Lord Edward Grosvenor.

Lord Edward Grosvenor joined the Royal Horse Guards in 1912 and in that year bought a Blériot monoplane on which he learnt to fly. He served throughout the war in France and Italy and was awarded the M.C. At the time of his death Lord Edward Grosvenor was Squadron Leader of No. 601 (County of London) (Bomber) Squadron, Auxiliary Air Force. Lord Edward Grosvenor was an Associate Fellow of the Society.

Dr. T. Blackwood Murray, who died on June 11th, 1929, was elected a Fellow of the Society in 1919. He was a brilliantly qualified engineer, a former President of the Institution of Engineers and Shipbuilders in Scotland. Dr. Murray carried out a considerable amount of research work on aero engine design and lubrication.

THE
ROYAL AERONAUTICAL SOCIETY
With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES
OCTOBER, 1929

Membership

On October 10th will be given the opening lecture of the Session by Mr. C. R. Fairey, M.B.E., F.R.Ae.S., on "The Range of Aircraft." The opening lecture is an important one and the Council hope that members will make a special point of attending, and bringing with them as many friends as possible, especially non-members of the Society.

The co-operation of all members of the Society is earnestly solicited to increase the present membership. The Society has now reached a position when a little effort on the part of every member to induce those who are eligible for membership to join will make it self-supporting, and will enable it to increase its already high prestige.

During the International Aero Exhibition the Secretary had the opportunity of meeting a large number of visitors from abroad, and from the opinions which were expressed it is understood that the Royal Aeronautical Society holds the premier position among technical aeronautical bodies throughout the world. It is to consolidate that position, to place and keep it on an unshakable base, that an appeal is made to every member to help.

There are many aeronautical engineers and others who have specialised knowledge of various branches of science and engineering allied to aeronautics who are not yet members of the Society. Apart from the *esprit de corps* which membership of a technical society brings, there is the definite concrete benefit to professional advancement which follows membership of the Society. The diplomas of Associate Fellowship, Associate Membership and Associateship give a technical standing which is now, under the new rules which call for high qualifications, recognised by the chief employers in the industry. The Council and Grading Committee number among their members leading aeronautical designers, employers and scientists, and the admission of any member to a technical grade is, in consequence, jealously guarded. The likelihood is that the rules for technical membership will be stiffened in the future.

Increased membership will allow the Society to increase its activities, and to obtain a wider technical outlook which an influx of new members brings. It is for these, among other reasons, that every member is asked to co-operate to keep the oldest aeronautical society in the world the most influential.

Contributions to the Journal

The Editor will be glad to consider technical articles for insertion in the JOURNAL, either on aviation or some allied subject. It is hoped that every member will look upon the JOURNAL as the medium for the publication of any original work. Special attention is drawn to the valuable awards and medals offered each year for which such work is eligible.

Assistant Secretary

Miss Olive St. Barbe St. Barbe has relinquished her position as Assistant Secretary. Miss St. Barbe joined the Society in 1917 and served during years of great difficulty, when her knowledge and ability proved to be of the greatest

possible assistance. At the Council Meeting, held on September 4th, a special honorarium was voted to Miss St. Barbe as a token of the Society's appreciation of her services during the past twelve years.

Council Meeting

A meeting of Council was held on Wednesday, September 4th, 1929, at 7, Albemarle Street, W.1.

Present: Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President), in the chair.
Major T. M. Barlow, M.Sc. (Eng.), M.Inst.C.E., M.I.Mech.E., F.R.Ae.S.
Mr. M. L. Bramson, A.C.G.I., F.R.Ae.S., M.I.Ae.E.
Air Vice-Marshal Sir Sefton Brancker (Past President), K.C.B., A.F.C., F.R.Ae.S.
Mr. Griffith Brewer, F.R.Ae.S.
Captain F. T. Hill, F.R.Ae.S., M.I.Ae.E., B.Sc., Wh. Ex.
Captain A. G. Lamplugh, F.R.Ae.S., M.I.Ae.E.
Mr. W. O. Manning, F.R.Ae.S.
Mr. C. C. Walker, Assoc.M.Inst.C.E., F.R.Ae.S.
Mr. McKinnon Wood, O.B.E., Assoc.M.Inst.C.E., F.R.Ae.S.
Air Vice-Marshal Sir Vyell Vyvyan (Vice-President), K.C.B., D.S.O.
Major D. H. Kennedy (Hon. Treasurer), O.B.E., F.R.Ae.S.

Among the items on the agenda which were considered were:—A review by the President of the effort of the Society at the International Aero Exhibition at Olympia, July, 1929; correspondence with the Secretary of the International Air Congress *re* making English an official language at this and future Congresses; the Finance Committee's report; the Grading Committee's report; the offer of Messrs. Gale and Polden to contribute 15 per cent. of the profits from a Civil Aviation Pocket Diary to the Endowment Fund; the Lecture Programme for the 65th Session; and the representation of the Society at the Antwerp Exhibition.

Lecture Programme

The Lecture Programme for the first half of the 65th Session is as follows:—

October 10th.—Mr. C. R. Fairey, M.B.E., F.R.Ae.S., "The Range of Aircraft."
October 24th.—Captain N. MacMillan, M.C., A.F.C., A.F.R.Ae.S., A.M.I.Ae.E., "The Art of Flying Land and Sea Machines."
November 7th.—Dr. A. E. Dunstan, "Recent Developments of Fuels and Dopes for Aircraft Engines."
November 21st.—Mr. L. W. Johnson, "The Inspection of Metals." (Joint meeting with the Institution of Automobile Engineers.)
November 28th.—Squadron Leader H. M. Probyn, D.S.O., "Flying and Maintenance from the Owner's Point of View."
December 5th.—Senor J. de la Cierva, "Recent Work on the Autogiro."
December 12th.—Dr. W. Rosenhain, D.Sc., F.R.S., "The Development of Materials for Aircraft Purposes."

The lectures in all cases will be delivered in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2. They will begin at 6.30 p.m. with the exception of the lecture on November 21st, which will begin at 7.45 p.m. and be a joint meeting with the Institution of Automobile Engineers.

Visitors are admitted to any lecture on signing the visitors' book with their full name and address.

Advance proofs of lectures will usually be available and may be obtained from the Secretary, price sixpence, or are sent post free for the first half on prepayment of 3s. 6d. and for the whole series 8s. od.

Endowment Fund

The steady increase in the membership of the Society in recent years has now reached a stage when it is felt by the Council that the growing prosperity and prestige of the Society can only be maintained by the provision of its own building and lecture hall. An Endowment Fund has been started with these objects in view and the Council hope that members will make every effort to add to the fund. Acknowledgments of contributions to the fund will be made in the JOURNAL as received.

Donations

The Council wish to acknowledge a generous gift of 150 negatives from Mr. W. O. Manning of aeroplanes, etc., taken between 1909 and 1914, and an album of newspaper photographs of flying in 1908-1909, containing a rare set of contemporary French postcards of famous pilots and their machines. Many of the photographs in Mr. Manning's collection are unique and have enabled the Society to fill up frequent gaps in their rapidly increasing file of historical photographs.

The Council gratefully acknowledge the gift from Mr. Oswald Short, of Messrs. Short Brothers, of an album of 30 photographs and copy negatives of old machines. These photographs include some of Sir Hiram Maxim's machine and early days of flying at Eastchurch and Brooklands.

The Council wish to acknowledge the gift of a number of JOURNALS by Mr. Griffith Brewer. Many of these JOURNALS are out of print and Mr. Brewer's gift has enabled the Society to fill in a large number of gaps. The Council will always welcome gifts of old JOURNALS for this reason, as many years are now incomplete.

Membership Badges

For those members of the Society who wish to have them, a badge has been prepared. The badge shows the symbols of the Society, the peregrine and balloon, in finely chased gilt on a blue enamel background, surrounded by a royal blue border on which appears the lettering "Royal Aeronautical Society, 1866." The badges have been hand made with the greatest care so that they will always retain their original appearance, and it is hoped that members will wear them on all suitable occasions. The price is 5/-, or 5/3 post free.

Souvenir Booklet

An illustrated Souvenir Booklet was printed in July describing the Society's exhibit at Olympia, and giving a history of the Society. This booklet supplements the account of the exhibit given in the present number of the JOURNAL, the two forming a complete record of the Society's activities at Olympia. It is hoped that every member who did not obtain his copy during the exhibition will buy one as a permanent record. The number available is limited and early application should be made, as it will not be possible to reprint. The price is one shilling, or 1/3 post free.

Forthcoming Events

Thursday, October 10th, 1929.—Lecture by Mr. C. R. Fairey, M.B.E., F.R.Ae.S., on "The Range of Aircraft," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

Thursday, October 10th, 1929.—Inaugural Meeting of Yeovil Branch.
Saturday, October 19th, 1929.—Conducted Tour of Petter's Engine Works and Foundry, arranged by the Yeovil Branch.
Thursday, October 24th, 1929.—Lecture by Captain N. MacMillan, M.C., A.F.C., A.F.R.Ae.S., A.M.I.Ae.E., on "The Art of Flying Land and Sea Machines," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.
Thursday, October 24th, 1929.—Lecture on "Steel Wing Construction," by Mr. Brian Martin, of the Steel Wing Co., before the Yeovil Branch.

Branches

YEOVIL BRANCH.

The following lectures and visits have been arranged by the Yeovil Branch:—

October 10th.—Inaugural Meeting.
October 19th.—Conducted Tour of Petter's Engine Works and Foundry.
October 24th.—"Steel Wing Construction," Mr. Brian Martin (Steel Wing Co.).
November 1st.—"Cold Working of Metals," J. W. Berry, Esq. (of Stourbridge Rolling Mills).
November 25th, 26th and 27th.—Film, "1/30th Part of a Hair," Alfred Herbert, Ltd.
December 5th.—"Aircraft Production Methods," D. B. Nivison, Esq. (Petters, Ltd.).
December 14th.—Visit to Whitby Bros. Gloving Factory, Yeovil.

COVENTRY BRANCH.

A lecture was delivered before the Coventry Branch on August 30th, by Squadron Leader C. E. Kingsford Smith and Flight Lieutenant C. P. T. Ulm on their recent trans-Pacific, Australia-New Zealand-Australia and Australia-England flights. The lecture was held in the Armstrong-Siddeley Dance Hall, under the chairmanship of Major F. M. Green, and there was an attendance of nearly 400.

On September 7th a trip was organised by the branch to see the Schneider Trophy Race from Lee-on-the-Solent.

J. LAURENCE PRITCHARD, *Secretary.*

OBITUARY

C. S. PAYNE.

The Council regret to record the death of Mr. C. Spencer Payne, B.Sc., M.C., who died in St. Thomas' Hospital after a short but severe illness. Mr. Payne joined the Society in 1912 and always took a keen interest in aviation. As long ago, as time is reckoned in aviation, as 1907 Mr. Payne gave a series of lectures on aeronautics at Sheffield University. He was a member of many other scientific bodies and on the outbreak of war in 1914 he was engaged on the design of airships. Mr. Payne was a man of very engaging personality and high integrity and the Council wish to express their keen sense of loss which they feel by his death.

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

NOVEMBER, 1929

Informal Dinner and Discussion

Arrangements are being made for holding a dinner (for men only), followed by an informal discussion, at the St. Ermin's Hotel, Caxton Street, Westminster (near St. James's Park Tube Station). The dinner will be held at 7.30 p.m. on Friday, November 15th, 1929, and the cost of tickets will be 6/6 each. Informal morning dress will be worn.

After the dinner, Major J. S. Buchanan, O.B.E., A.M.I.Mech.E., F.R.Ae.S., will move—

> "That this meeting is of the opinion the present rules for the Schneider Trophy Race and the High Speed Record are not consistent with the proper development of high-speed aircraft."

The chair will be taken by Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S., President of the Society, and it is hoped that every member will make a special effort to be present. Members may bring guests to the dinner if they wish.

Early application is essential. These informal discussions have been very successful in the past, and have enabled those present to speak with more freedom than has been found possible at the more formal lectures. By a special resolution of Council the speeches will not be reported.

Council Meeting

A Meeting of Council was held on Tuesday, October 8th, 1929. Present:—Colonel the Master of Sempill (President) in the chair.

Major T. M. Barlow.
Mr. M. L. Bramson.
Mr. Griffith Brewer.
Captain F. T. Hill.
Lieut.-Col. J. T. C. Moore-Brabazon.
Wing Cmdr. T. R. Cave-Browne-Cave.
Mr. T. O. M. Sopwith.
Captain A. G. Lamplugh.
Major A. R. Low.
Mr. Handley Page.
Mr. H. E. Wimperis.
Mr. McKinnon Wood.
Mr. L. A. Wingfield (*Hon. Solicitor*).
Mr. J. E. Hodgson (*Hon. Librarian*).
Major D. H. Kennedy.

Among the matters considered were:—The award of the Elliott Memorial Prize for the year 1928-29; regulations for the Prize in future years; appointment of representatives to the Daniel Guggenheim Safety Competition; the report of the Grading Committee; the report of the Finance Committee; the report of the Informal Discussions Committee; the lecture programme for second half of the 65th Session; appointment of representative of the Society on the B.E.S.A. Committee on symbols and abbreviations used in engineering.

Elections

The following recommendations of the Grading Committee were approved by the Council at their meeting on Tuesday, October 8th, 1929:—

Fellow.—Horatio Barber (re-elected).

Associate Fellows.—Kenneth Watson Clark, John Myles, Sydney James Waters (re-elected).

Associate Member.—Alan Theodore Eden Eadon (re-elected).

Associates.—Thomas George Barton, Edmund Neil Boileau Bentley (from Student), James Edward Blum (from Student), Albert Edward Clifford, John Purvis Gibb.

Students.—Gerald Napier Ashcroft, George W. G. Brammer, John Joseph Green, Jack Hedges, Lancelot Elworthy Jarman, Elsie Joy Muntz, Derek Price, Henry Cyril Robinson, Frederick William Sainsbury, Frank Wattendorf.

Companions.—Alexander Duckham, Amy Johnson, Alexander Edward Wrottesley Salt.

Honorary Membership

At the meeting of the Society to be held on Thursday, November 21st, the President will propose, on behalf of the Council, that Professor Payne, Dean of the Faculty of Engineering at Melbourne University, shall be elected an Honorary Fellow of the Society, and Captain Roach-Pierson, Member, shall be elected an Honorary Member of the Society, in recognition of their distinguished services to aviation.

Professor Payne is chairman of the Air Accidents Committee in Australia and has been identified with aviation in the Dominion for a number of years.

Captain P. Roach-Pierson, a Member of the Society, was the Honorary Secretary of the Australasian Branch from 1920-1927, and it was entirely due to his initiative and energy that the branch was not only formed but kept in existence.

The Necessity for Municipal Air Ports

A Conference on the Necessity for Municipal Air Ports will be held in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, on Tuesday, 5th November, under the auspices of the Royal Aeronautical Society, the Royal Aero Club, and the Air League of the British Empire. The Conference will begin at 2.30 p.m. precisely, and admission is by invitation ticket only.

The Conference was called after consultation with the Air Ministry (through Sir Sefton Brancker, Director of Civil Aviation), the Royal Aero Club and the Air League of the British Empire, following the recent air tour of Sir Alan Cobham. The Conference will be addressed on questions relating to the construction, organisation and operation of municipal air ports, by Lord Thomson, Sir Sefton Brancker, and leading Air Ministry officials. Among others who are being invited are Lord Herbert Scott, President of the London Chamber of Commerce, the Chairman of the Society of British Aircraft Constructors, and the Presidents of the Institutions of Civil, Mechanical and Electrical Engineers and other societies. The chair will be taken by the President of the Royal Aeronautical Society, Colonel the Master of Sempill.

Photographs Received and Wanted

The Council wish to acknowledge the gift of photographs of H.M.A. "Beta" from M. Downer, and also autographed photographs of Sir John Alcock and Sir Arthur Whitten Brown and Sir Ross Smith and Sir Keith Smith, with their Vickers-Vimy Rolls aeroplanes from Mrs. O'Brien, widow of the late H. S. O'Brien. The Society has a large classified collection of photographs, and it is hoped that any members who have photographs to spare, especially of the period 1906-1915, will present copies to the Society, to enable it to fill up gaps in the series. All such photographs received, of aircraft, aircraft parts and construction, or aviation personalities, will be acknowledged in the JOURNAL

Royal Air Force Display, 1930

The Royal Air Force Display will be held on Saturday, June 28th, 1930, at the R.A.F. Station, Hendon.

Contributions to the Journal

The Editor will be glad to consider technical articles for publication in the JOURNAL, either on aviation or some allied subject. It is hoped that every member will look upon the JOURNAL as the medium for the publication of any original work. Special attention is drawn to the valuable awards and medals offered each year for which such work is eligible. Full particulars of these awards will be sent on application.

Membership Badges

For those members of the Society who wish to have them, a badge has been prepared. The badge shows the symbols of the Society, the peregrine and balloon, in finely chased gilt on a blue enamel background, surrounded by a royal blue border on which appears the lettering "Royal Aeronautical Society, 1866." The badges have been hand made with the greatest care so that they will always retain their original appearance, and it is hoped that members will wear them on all suitable occasions. The price is 5/-, or 5/3 post free.

Souvenir Booklet

An illustrated Souvenir Booklet was printed in July describing the Society's exhibit at Olympia, and giving a history of the Society. This booklet supplements the account of the exhibit given in the October number of the JOURNAL, the two forming a complete record of the Society's activities at Olympia. It is hoped that every member who did not obtain his copy during the exhibition will buy one as a permanent record. The number available is limited and early application should be made, as it will not be possible to reprint. The price is one shilling, or 1/3 post free.

Endowment Fund

The steady increase in the membership of the Society in recent years has now reached a stage when it is felt by the Council that the growing prosperity and prestige of the Society can only be maintained by the provision of its own building and lecture hall. An Endowment Fund has been started with these objects in view and the Council hope that members will make every effort to add to the fund. Acknowledgments of contributions to the fund will be made in the JOURNAL as received.

Technical Index

For the past two years the Secretary has been laying the foundation of a Technical Index which, it is hoped, will be of some value to members of the Society.

The main object of this card index is to provide references to technical articles, official reports, papers, lectures, etc., on all aspects of aviation and its allied sciences. A very wide field has been covered, and though the index does not pretend to be exhaustive, it is very comprehensive. Among sources of information which have been indexed may be mentioned:—

(*a*) The leading aeronautical papers in Great Britain, Germany, France, Italy, America.

(*b*) Official reports, including R. & M.'s, N.A.C.A. Reports and Technical Notes, Göttingen, Koutchino Laboratory, Amsterdam

Institute, Aeronautical Institute of Tokyo, Italian Aeronautical Institute, Brussels Aeronautical Institute, and Canadian Air Board Reports.

(*c*) Library of Royal Aeronautical Society, Library of Congress, Washington Public Library.

(*d*) Scientific journals.

(*e*) Abstracts prepared by various bodies and institutions.

The index contains approximately some 20,000 entries and is being continually added to. The cards are arranged under subject headings and copiously cross-referenced.

It is hoped that members of the Society will make free use of this technical index and get into the habit of looking upon the Society as the headquarters from which references to aeronautical information can be readily obtained. It should be understood that, as a general rule, references only to any particular subject can be given, as the work involved in sending the actual information would mean employing a very much larger staff than the Society at present can afford.

Forthcoming Events

November 1st.—" Cold Working of Metals," Lecture before the Yeovil Branch, by J. W. Berry.

November 4th.—Lecture by Professor M. Jones before the Oxford Branch.

November 5th.—Air Conference in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, Embankment, 2.30 p.m. precisely. The Conference will be addressed by Lord Thomson, Secretary of State for Air, Sir W. S. Brancker, Director of Civil Aviation, and other leading Air Ministry officials.

November 7th.—Lecture by Dr. A. E. Dunstan, on " Recent Developments of Fuels and Dopes for Aircraft Engines," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

November 8th.—" Aero Brakes," Lecture before Yeovil Branch, by Mr. B. C. Hall.

November 8th.—Opening Meeting of Leeds Branch.

November 14th.—" Aircraft in Canada," Lecture before the Yeovil Branch, by Squadron Leader D. C. M. Hume.

November 15th.—Informal Dinner and Discussion, at 7.30 p.m., at the St. Ermin's Hotel, Westminster, S.W.1.

November 18th.—" The Schneider Trophy Race and the Air Speed Record," Lecture before the Oxford Branch, by Squadron Leader Orlebar.

November 21st.—" Wing Flutter," by Mr. Fraser, Lecture before the Bristol Branch.

November 21st.—Lecture by Mr. L. W. Johnson on " The Inspection of Materials," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at **7.45 p.m.** Refreshments will be served from 7.0 p.m. in the Library of the Royal Society of Arts.

November 22nd.—" Aero Wheels and Tyres," Lecture before the Yeovil Branch.

November 28th.—Lecture by Squadron Leader H. M. Probyn, D.S.O., on " Flying and Maintenance from the Owner's Point of View," in the Lecture Hall of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2, at 6.30 p.m.

J. LAURENCE PRITCHARD, *Secretary.*

THE

ROYAL AERONAUTICAL SOCIETY

With which is incorporated the Institution of Aeronautical Engineers

MONTHLY NOTICES

DECEMBER, 1929

Donations to Society's Funds

The Council wish to acknowledge the magnificent donation of $10,000 from the Daniel Guggenheim Fund for the Promotion of Aeronautics. The following cables have been received and sent:—

"Have pleasure informing you Guggenheim Fund has awarded final grant of ten thousand dollars to enable Society continue for further two years the work previously supported by fund. Please cable acknowledgment.—MAYO, Guggenheim Fund, New York."

"HARRY GUGGENHEIM. Council and all members deeply touched by your continued interest and confidence in the Society's ability to further the cause of aeronautics so greatly aided throughout the world by the Daniel Guggenheim Fund. But for the generous support received from the fund in the past our activities would have been considerably restricted. The munificent donation just received will enable us to continue these activities and lead to the Society attaining a position of greater strength and independence.—SEMPILL, *President*."

For the fifth year in succession the Society of British Aircraft Constructors have granted a sum of £250 to further the objects of the Society. The generous support of the Society of British Aircraft Constructors has enabled the Council to proceed with schemes which would otherwise have been held in abeyance, and the Council wish to place on record their great gratification at the attitude of the trade body towards the Society.

Council Meeting

A Meeting of Council was held on Tuesday, November 19th, 1929, at 7, Albemarle Street, W.1. Present:—

Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President), in the chair.

Major T. M. Barlow.
Mr. M. L. Bramson.
Sir W. Sefton Brancker.
Mr. Griffith Brewer.
Major J. S. Buchanan.
Captain F. T. Hill.
Major D. H. Kennedy (Hon Treasurer).
Major A. R. Low.
Mr. W. O. Manning.
Mr. C. C. Walker.
Mr. L. A. Wingfield (Hon. Solicitor).
Mr. H. E. Wimperis (Vice-President).

Among the business which was discussed was the following:—The Guild of Air Pilots and Air Navigators; the Report of the Finance Committee; the Report of the Grading Committee; the Report of the Medals and Awards Committee;

the appointment of an Education and Examinations Committee; participation in the proposed Exhibition at Stockholm, 6th-28th September, 1930; letters to the Guggenheim Fund for the Promotion of Aeronautics and the Society of British Aircraft Constructors making donations to the Society; and the question of a donation towards placing a memorial plaque to the late Mr. G. Holt Thomas in the waiting hall at the Croydon Aerodrome.

Elections

The names of those members elected at the November meeting of Council are given on pages 1169-1172 of the JOURNAL.

Preliminary Details of the Lecture Programme, Second Half of Session 1930

Thursday, January 9th.—Mr. R. McKinnon Wood, O.B.E., F.R.Ae.S., A.M.Inst.C.E., "The New American Wind Tunnel."

Thursday, January 23rd.—Mr. H. B. Howard, B.A., B.Sc., A.F.R.Ae.S., "Certificates of Airworthiness."

Thursday, February 6th.—Mr. J. W. Maccoll, B.Sc., A.F.R.Ae.S., "Modern Research in Germany."

Thursday, February 13th.—Senr. J. de la Cierva, "Recent Progress with the Autogiro."

Wednesday, February 19th.—Dr. Walter Georgii, "Gliding."

Thursday, February 27th.—Mr. A. J. Rowledge, M.I.A.E., F.R.Ae.S., A.M.Inst.C.E., "Latest Developments of Aero Engine Practice." (Joint Meeting with Institution of Automobile Engineers.)

Thursday, March 6th.—Major F. M. Green, O.B.E., M.Inst.C.E., F.R.Ae.S., and Mr. H. C. H. Townend, "Resistance of Air-Cooled Engines."

Monday, March 10th.—Herr Wronsky, "Air Transport." (Joint Meeting with Institute of Transport.)

Thursday, April 3rd.—Mons. P. Grimault, "Operation of the Aero-Postale Service in Europe."

Donations

The Council wish to acknowledge their appreciation of a gift of books of old newspaper cuttings of airships and balloons from E. Townsend, Esq., and of three bound volumes of the catalogues issued by the London Aerodrome at Hendon for the years 1912-13-14 from W. S. Robson, Esq.

Donation of Photographs

The Council wish gratefully to acknowledge gifts of photographs to the Society's collection from Messrs. The Hawker Engineering Company, Messrs. Napier, Ltd., and the Monospar Wing Company.

The Council are very anxious to make the Society's collection of photographs of aeroplane subjects as complete as possible, and hope that every member will assist them as far as they are able to attain this object. Photographs are particularly wanted of aeroplanes, engines, personalities, and scenes covering the period 1906-1914, as these photographs are at present very incomplete.

Students' Meeting

There will be a lecture by Mr. F. G. Evans before the Students' Section of the Society, in the Library, at 6.45 p.m., on December 17th. The subject of the lecture will be "The Method of 'Least Work' of the Stressing of Aeroplane Structures," and the chair will be taken by Mr. H. B. Howard, A.F.R.Ae.S., of the Air Ministry.

The Schneider Trophy Seaplane

The S.6, the winning seaplane in the Schneider Trophy contest for 1929 is on view in the Aeronautical Section of the Science Museum at South Kensington.

Guild of Air Pilots and Air Navigators

The Guild of Air Pilots and Air Navigators of the British Empire is open to certificated Air Pilots and Air Navigators who are British subjects, whether resident at home or abroad, and who are Master Pilots or have been for not less than five years the holders of a " B " Pilot's licence, or First Class Airship Pilot's licence, or a certificate of competency as a First Class Navigator of Commercial Aircraft.

During the first year of the Guild's existence the five years' qualification will be waived and the Court have a discretion as to whom they elect. Applications for membership should be made to the Clerk of the Guild, L. A. Wingfield, Esq., Guild of Air Pilots and Air Navigators of the British Empire, 61, Cheapside, London, E.C.2.

Fifth International Congress at The Hague

The following letter has been written to the Secretary of the Fifth International Congress, following correspondence *re* the use of English as an official language at the Congress:—

> " Dear Sir,—I am instructed by the Council, further to my correspondence dated May 13th, to say that as the English language is not to be officially recognised at the coming Conference the Council regret that they cannot take part in the Congress."

Yeovil Branch

The following lectures have been arranged before the Yeovil Branch:—

January 16th.—Wireless Apparatus for Aircraft, by representative of Marconi Wireless Telegraph Co., Ltd.

January 23rd.—Wapiti Steel Wing Construction, by Mr. Brian L. Martin, B.Sc.

February 1st.—The Westland Wapiti in Service, by an Officer of the R.A.F.

February 6th.—Aircraft Production Methods, by Mr. D. B. Nivison.

February 20th.—The Schneider Trophy Contest of 1929, by Flight Lieut. H. R. W. Waghorn, A.F.C.

March 7th.—The Gypsy Aero Engine, by a representative of De Havilland's.

March 19th.—High Altitude Equipment for Aircraft, by Major C. J. Stewart, O.B.E., F.R.Ae.S.

Journals Wanted

The following numbers of the JOURNAL are wanted by a member. If any member wishes to sell his copies will he please write and state the price wanted for them?

No. 1, April, Vol. I, 1897; No. 2, January, Vol. II, 1898; No. 3, January, Vol. III, 1899; No. 25, April, Vol. VII, 1903; No. 25, July, Vol. VII, 1903; No. 25, October, Vol. VII, 1903; No. 29, July, Vol. VIII, 1904; No. 33, July, Vol. IX, 1905; No. 37, April, Vol. X, 1906; No. 37, July, Vol. X, 1906; No. 37, October, Vol. X, 1906; No. 41, April, Vol. XI, 1907; No. 46, January, Vol. XII, 1908; No. 46, October, Vol. XII, 1908; No. 50, January, Vol. XIII, 1909; No. 50, October, Vol. XIII, 1909; No. 57, April, Vol. XV, 1911; No. 81, January to June, Vol. XXI, 1917; No. 96, December, Vol. XXII, 1918; No. 107, November, Vol. XXIII, 1919; No. 109, January, Vol. XXIV, 1920; No. 113, May, Vol. XXIV, 1920; No. 116, August, Vol. XXIV, 1920.

Forthcoming Events

Wednesday, December 4th.—Lecture before Students' Section, by Mr. E. H. Lewitt, on "Airship Design." Joint Meeting with City and Guilds' Engineering Society.

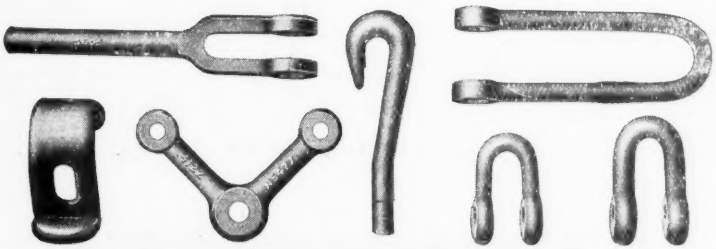
Thursday, December 5th.—Lecture before the Yeovil Branch on "The Airship R.100," by Mr. R. B. Brigham, A.R.Ae.S.I.

Thursday, December 12th.—Lecture by Dr. W. Rosenhain, F.R.S., on "The Development of Materials for Aircraft Purposes," at 6.30 p.m., in the Lecture Hall, of the Royal Society of Arts, 18, John Street, Adelphi, W.C.2.

Tuesday, December 17th.—Lecture before the Students' Section, by Mr. F. G. Evans, on "The Method of Least Work and the Stressing of Aeroplane Structures." In the Library at 6.45 p.m. Mr. H. B. Howard in the chair.

J. LAURENCE PRITCHARD, *Secretary.*

Drop Forgings



GARRINGTON

JOHN GARRINGTON & SONS, LTD.
ALBERT WORKS - - - DARLASTON.

IMPERIAL

PANCHROMATIC & ORTHOCHROMATIC FILM

GIVES UNEQUALLED SATISFACTION
for AERIAL SURVEY WORK

Details and prices gladly supplied on application.

Whether you use films or plates for your photography, insist on "Imperial" and ensure the highest quality obtainable.

THE IMPERIAL DRY PLATE CO., LTD.,
Cricklewood, London, N.W.2.

Telephone: Willesden 4286. *Telegrams: "Impeople, Crickle, London."*

Clyde Alloy

AIRCRAFT STEELS

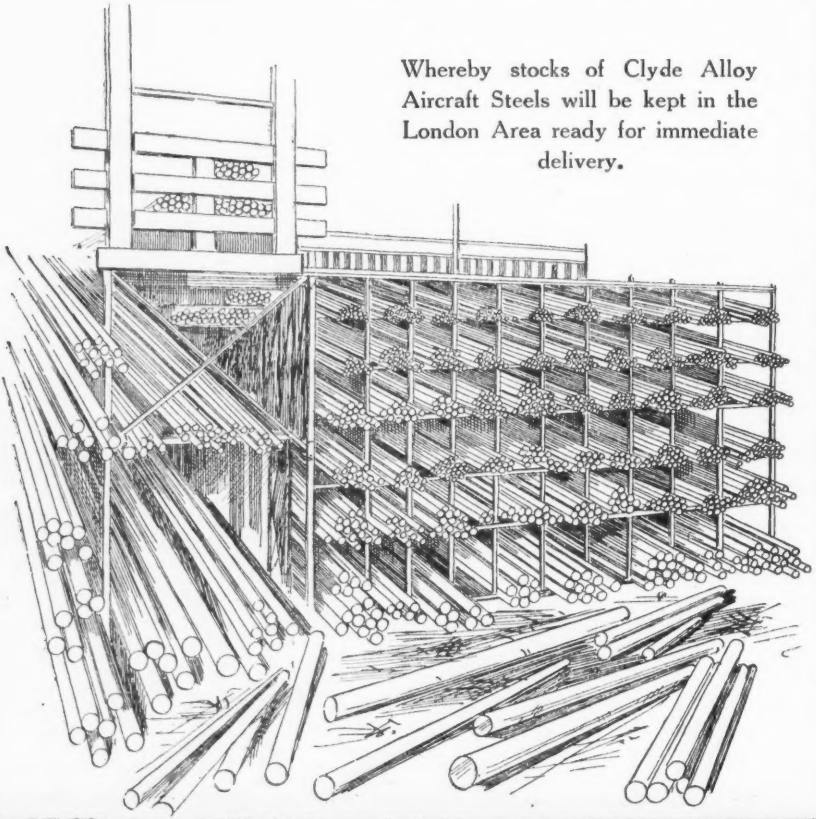
FROM **STOCK**

CAN BE SUPPLIED BY

AIRCRAFT MATERIALS Ltd.

MIDLAND ROAD, LONDON, N.W.1,

Whereby stocks of Clyde Alloy Aircraft Steels will be kept in the London Area ready for immediate delivery.



THE CLYDE ALLOY STEEL CO. LTD.

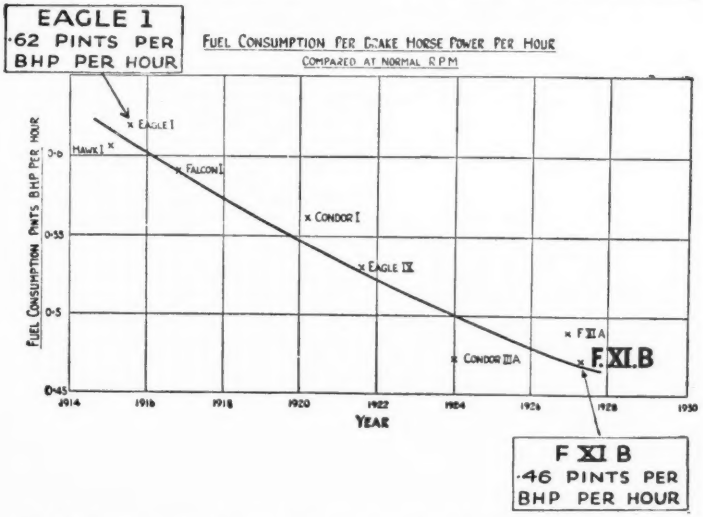
CRAIGNEUK WORKS, MOTHERWELL.

Telegrams CLYDALL, MOTHERWELL. *Telephone*: **357** MOTHERWELL.

ROLLS-ROYCE

AERO ENGINES

PROGRESS: 3. Fuel Economy



Rolls-Royce Ltd. have always recognised the importance to Aviation of low fuel consumption. This curve shows how they have steadily progressed for the last 14 years. To-day their latest F.B type engine is the most economical aeroplane engine in the world.

Rolls-Royce Limited

14-15 Conduit St. London W.1

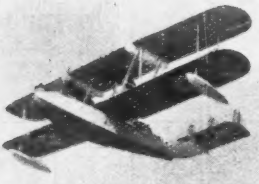
Telephone Mayfair 6040

THE SUPERMARINE AVIATION WORKS LTD.

PROPRIETORS:

VICKERS [AVIATION] LIMITED,

SOUTHAMPTON.



THE SUPERMARINE NAPIER "SOUTHAMPTON" SHOWN ABOVE IS OF THE TYPE LOANED BY THE AIR MINISTRY TO ASSIST IN THE RE-ESTABLISHMENT OF THE AIRWAY TO INDIA.

THE RELIABILITY OF THESE MACHINES WAS AN OUTSTANDING FEATURE OF THE R.A.F. FAR EAST FLIGHT OF 27,000 MILES.

"SOUTHAMPTONS"

OF

METAL CONSTRUCTION

SOUND AND MACHINABLE

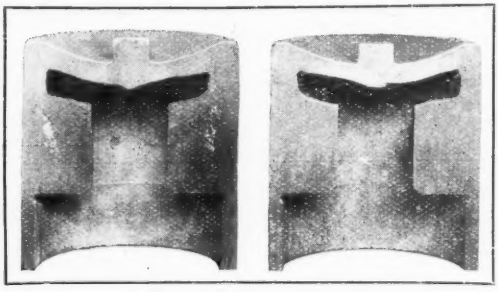
Pistons

in

Nickel Cast Iron

made by

EALING PARK FOUNDRY LTD.



THE piston shown on the left illustrates the usual form of porosity which occurs in this design when the ordinary cast iron mixture is controlled to give a casting, machinable all-over. The bosses in the casting could be rendered sound by the reduction of silicon, but then the skirt is unmachinable owing to chill and hard spots.

Ealing Park Foundry Ltd have overcome this trouble entirely by the use of nickel, as illustrated by the right-hand piston. The proper use of nickel has got rid of the tendency to openness in the heavy sections without in any way impairing the machinability.

Our technical literature and the services of our technical staff are at the disposal of all manufacturers and users of cast iron. Write for our free publications on Nickel Cast Iron.

THE BUREAU OF INFORMATION ON NICKEL

THE MOND NICKEL COMPANY LTD. IMPERIAL CHEMICAL HOUSE, MILLBANK S.W.1
AND SUBSIDIARIES

PARNALL AIRCRAFT

World-Famed for Speed & Reliability.

PARNALL "PETO."

Two-seater Reconnaissance Machine. Folding Wings.
Mongoose or Lucifer Engine.

GEORGE PARNALL & CO.,

COLISEUM WORKS, PARK ROW,
BRISTOL, ENGLAND.

Telephone: 4773 Bristol P.B.Ex. (3 lines). Telegrams: "Warplanes, Bristol."

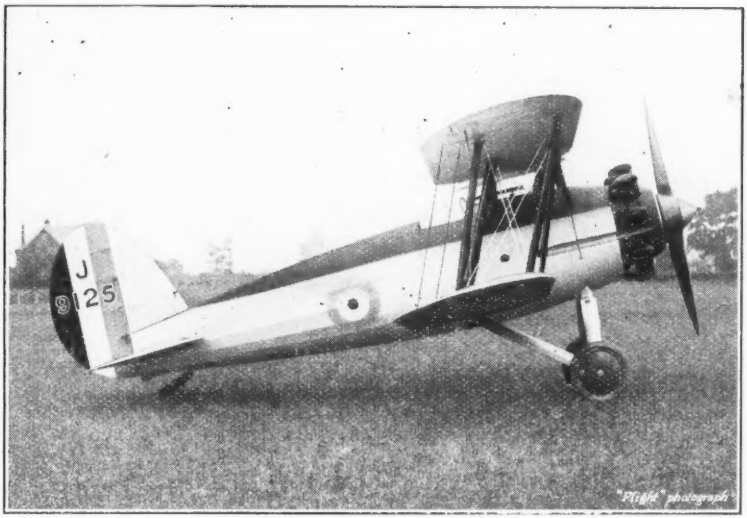
London Office: **EVELYN HOUSE, 62, OXFORD STREET, W.1.**
Telephone: Museum 7101.

Factories: **PARK ROW, MIVART STREET, BRISTOL.**

Experimental Works and Test Station: **YATE AERODROME, GLOUCESTERSHIRE.**
Tel.: Chipping Sodbury 50.

GLOSTER

The Pioneers of Steel Aircraft and Variable Pitch Propellers.



Gloster All-metal Single Seater Fighter.

For performance, fighting view and manœuvrability, it is impossible to find a machine to equal the Gloster All-metal Single Seater Fighter. Its construction has been described as an engineering triumph. Ease of maintenance in the field, and interchangeability of parts, are other special features.

GLOSTER AIRCRAFT Co. Ltd.

SUNNINGEND, CHELTENHAM.
GLOSTER WORKS and AERODROME, BROCKWORTH, Glos.

THE STEEL WING Co. Ltd.

THOMAS SMITH'S
STAMPING WORKS LTD.
COVENTRY

MODERN METHODS, RIGID INSPECTION, HEAT TREATMENT AND TESTING, BY A COMPETENT STAFF, IN A MODEL FACTORY, GUARANTEE CONFORMITY TO ALL STANDARD SPECIFICATIONS FOR

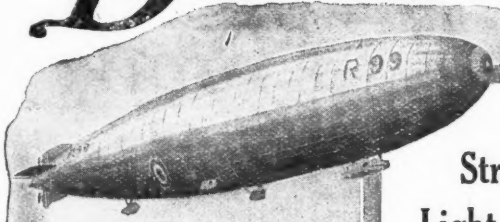
AIRCRAFT
DROP FORGINGS

STEEL. - DURALUMIN. - "Y" ALLOY.

Telegrams: "FORCE, COVENTRY"
Telephones: 3151 AND 3152

"VICKERS' Duralumin"

Registered Trade Mark

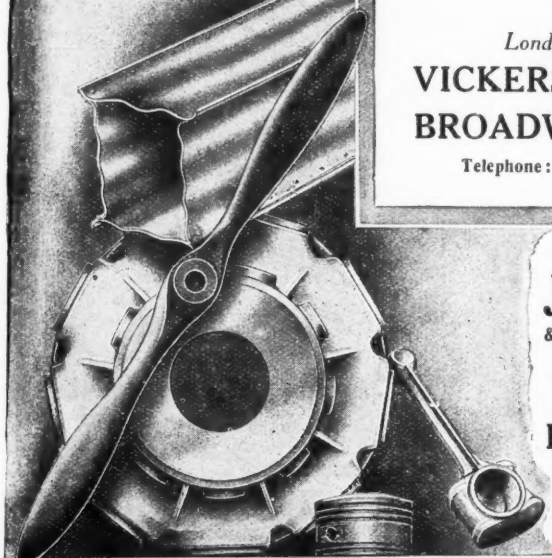


STRENGTH COMBINED WITH LIGHTNESS

Strong as Steel.
Light as Aluminium.

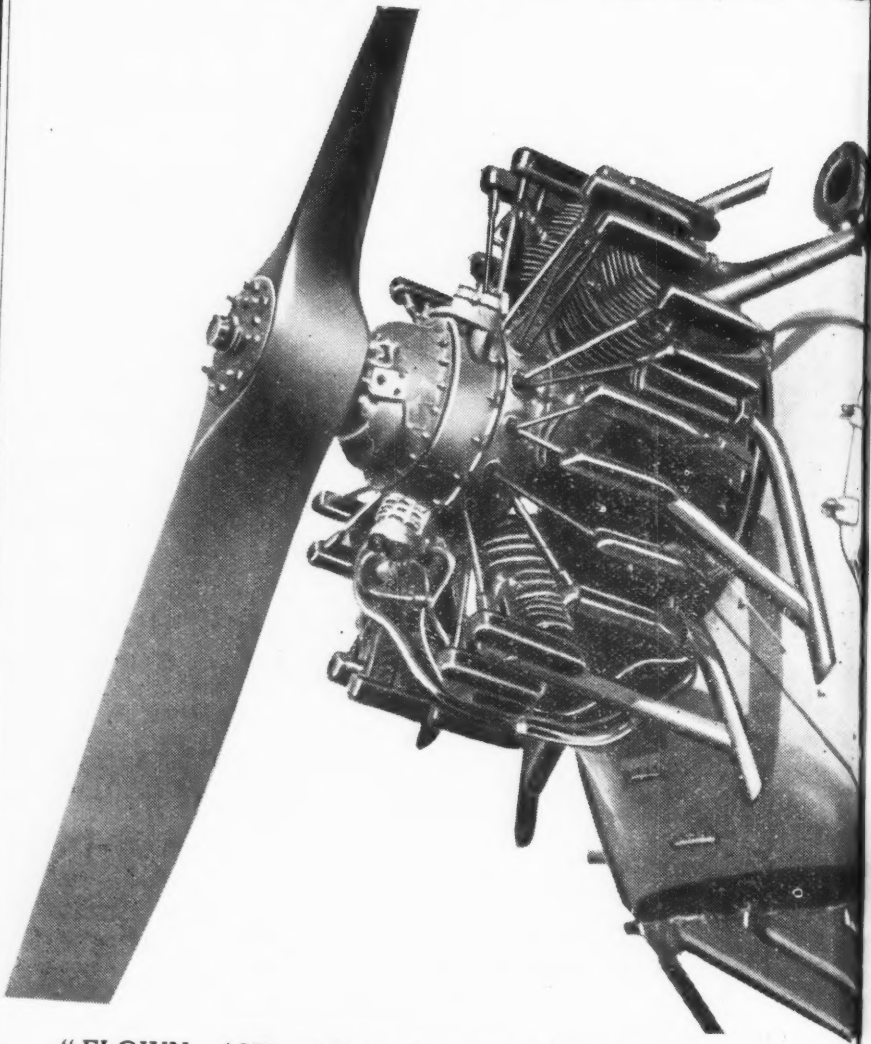
An alloy with the strength and hardness of Mild Steel, but having only one-third of its weight, and possessing excellent machining qualities.

London Office:
VICKERS HOUSE, BROADWAY, S.W.1
Telephone: Victoria 6900.



All inquiries to :—
JAMES BOOTH
& COMPANY (1915) LIMITED,
Argyle Steel Works,
NECHELLS,
BIRMINGHAM.
Telephones: East 1221, Private Branch Exchange.
Telegrams: "Booth," Birmingham.
Cables: Liebers 5 Letter Code, Bentley's, A.B.C. 5th & 6th Edit's.

The LEADING



"FLOWN AND KNOWN ALL OVER THE WORLD."

AIR LINES

in

England, Australia, East Africa, France, Switzerland, Italy, Spain and Holland,

have all chosen

ARMSTRONG SIDDELEY

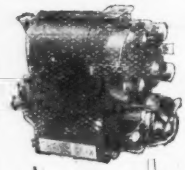
Air-cooled

ENGINES

for powering their

commercial aircraft

ARMSTRONG SIDDELEY MOTORS LIMITED,
Head Office and Works: Coventry. London: 10, Old Bond Street, W.1.



First and Foremost

SIMMS Magnetos are used by those manufacturers who put quality before price, and who will include only the finest material and equipment in their designs. Nearly 80% of commercial vehicle manufacturers use "SIMMS All-British Magnetos." Specify

Simms
MAGNETOS

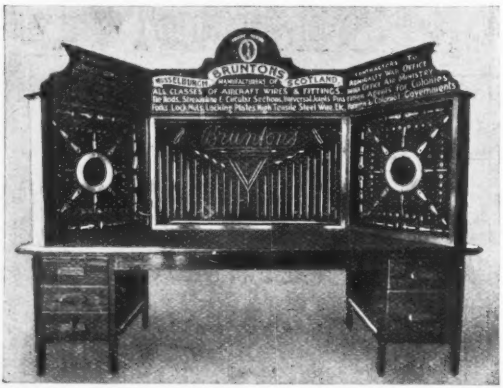
SIMMS MOTOR UNITS, Ltd.,

Works: GRESSE STREET, LONDON, W.1

Service Branches in all Principal Centres.

We Manufacture:

TIE RODS



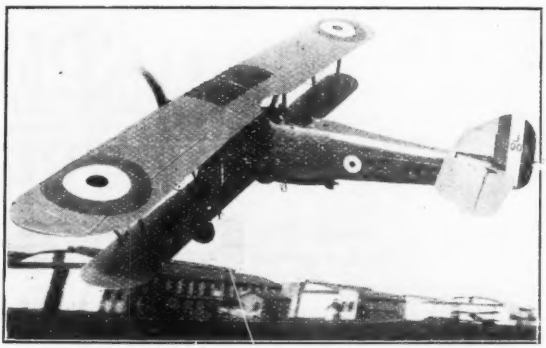
STREAMLINE WIRES

AIRCRAFT WIRES and FITTINGS, CABLE and BRUNTONISED WIRE
FOR AIRSHIPS AND AEROPLANES.

BRUNTONS—MUSSELBURGH—SCOTLAND

London Office—33-34, CRAVEN HOUSE, KINGSWAY, W.C.2.

Photograph by courtesy of "Flight."



THE "HORSLEY" TORPEDO BOMBER.

THE H.G. HAWKER ENGINEERING CO., LTD.,

Designers and Constructors of
:: All Types of Aircraft. ::

Contractors to H.M. Air Ministry and Foreign Governments.

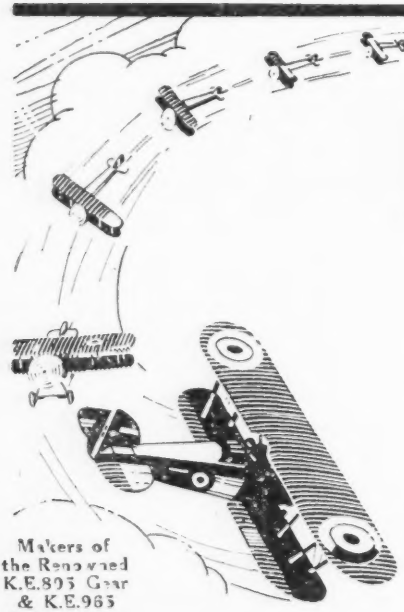
Offices and Works: **KINGSTON-ON-THAMES. SURREY.**
Aerodrome: **BROOKLANDS. SURREY.**

Telephone: Kingston 6272 (4 lines).
Telegrams: Hawker, Kingston.

STRIP STEEL

SPECIALISTS IN THE ROLLING AND
—— HEAT TREATMENT OF ——
AIRCRAFT STRIP AND SHEET STEEL

J. J. HABERSHON & SONS, Ltd.,
HOLMES MILLS, ROTHERHAM.



Makers of
the Renowned
K.E.893 Gear
& K.E.965
Valve Steels.

K.E. SPECIAL STEELS FOR AIRCRAFT.

K.E. 965 Special Steel Valves were used by HINKLER in the Air-cooled "CIRRUS" Engine of his AVRO on his memorable Australian Flight.

The world-famous BRISTOL JUPITER Air-Cooled Radial Engines are also fitted with K.E. 965 Special Steel Valves.

KAYSER, ELLISON & Co., Ltd.
Carlisle Steel Works - SHEFFIELD.
Established over 100 years.

R.A.S.J. 12/29.

R.100

framework is of
DURALUMIN
(aluminium
alloy)

Aluminium

The British Aluminium Co., Ltd., Adelaide House, London, E.C.4.

DROP STAMPINGS FOR AIRCRAFT WORK

Daniel Doncaster & Sons Ltd. have made a specialty of drop forgings of all descriptions, particularly from alloy steels, heat-treated to any specification and to the most rigid inspection. Their lengthy experience and choice of several types of plant place them in a very favourable position for rendering economical service, especially to the Aircraft Industries. Ordinary forgings of all descriptions from the smallest up to four tons are also undertaken; die blocks for drop stampings are supplied.

A special department is devoted to the production of valve forgings for Aero requirements.

Highest grade quality at lowest possible cost is the keynote.

The new Government Airship R101 employs Doncaster's Drop Forgings.

THE UNITED STEEL COMPANIES LTD

DANIEL DONCASTER & SONS LIMITED

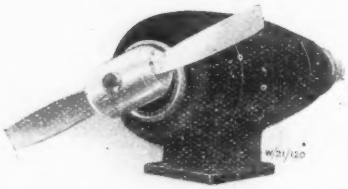
Associated with The United Steel Companies Limited

SHEFFIELD

ΦD2a

HASLAM & NEWTON LTD., formerly

NEWTON BROTHERS (Derby) LTD.



LIGHT-WEIGHT STREAMLINED AIRCRAFT GENERATOR DRIVEN BY CONSTANT SPEED VARIABLE PITCH WINDMILL.

THE PIONEER MANUFACTURERS OF LIGHT-WEIGHT AIRCRAFT GENERATORS AND SPECIALISTS IN THE DESIGN OF ELECTRICAL MACHINERY FOR ALL PURPOSES.

WE DESIGNED AND MANUFACTURED THE COMPLETE ELECTRICAL EQUIPMENT FOR H.M. AIRSHIP R. 101.

London Office:
IMPERIAL BLDGS., 56, KINGSWAY, W.C.2.
Telephone—HOLBORN 0531.
Telegrams—"Ponfex Phone London."

Head Office and Works:
ALFRETON ROAD, DERBY.
Telephone—DERBY 1610.
Telegrams—"Dynamo Derby."

SHORT & MASON, LTD.

Scientific Instrument Manufacturers,

ANEROID WORKS, MACDONALD ROAD, WALTHAMSTOW,

Tycos **LONDON, E.17.** **ESTABLISHED 1864.**

Manufacturers of Altimeters and Altigraphs for Aeronautical Purposes.

Contractors to War Office, Admiralty, India Board, Meteorological Offices, Canadian and S. African Governments, Australian Commonwealth, &c.

A AND P

TUBES FOR AIRCRAFT

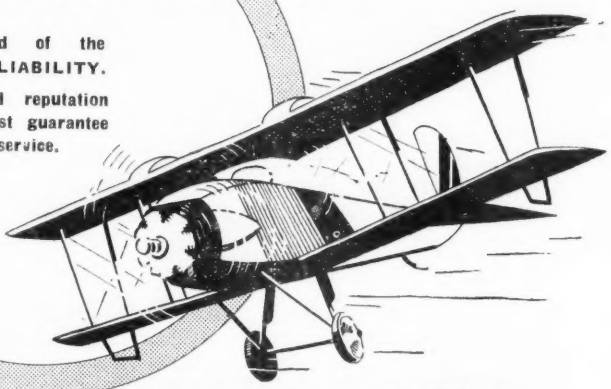
A New Edition of Our Catalogue of Special Sections of Weldless Steel Tubes is now ready. If you have not received your copy, please make application. This Catalogue shows nearly 800 different Special Sections, including the British and American Standard Streamlines.

ACCLES & POLLOCK LTD
OLDBURY BIRMINGHAM

ALUMINIUM AIR CRAFT CASTINGS

The watchword of the airways is RELIABILITY.

Our established reputation is your soundest guarantee of satisfactory service.



WILLIAM MILLS LTD
ATLAS ALUMINIUM WORKS · GROVE STREET · BIRMINGHAM

Pratts INVINCIBLE!

Triumph after Triumph on Pratt's High Test.

KING'S CUP
GROSVENOR CUP
AIR LEAGUE CUP
SIDDELEY TROPHY
BRITISH AIRCRAFT
CONSTRUCTORS' CUP

SCHNEIDER TROPHY *and the*
WORLD'S FASTEST SPEED
on Pratt's Ethyl Petrol.

ANGLO-AMERICAN OIL CO., LTD.,
36, QUEEN ANNE'S GATE, S.W.1.

AERONAUTICAL PUBLICATIONS.

TRANSACTIONS OF THE ROYAL AERONAUTICAL SOCIETY

Original Papers of a Fundamental Character in the Science of Aeronautics

The Calculation of Stresses in Aeroplane Wing Spars, by Arthur Berry, M.A. 5/-
Position Fixing in Aircraft During Long-Distance Flights Over the Sea, by Instructor-Comdr. T. Y. Baker, R.N., and Major L. N. G. Filon, D.Sc., F.R.S., late R.A.F. 5/-
Aero Engine Efficiency, by Dr. A. H. Gibson 5/-

MISCELLANEOUS PUBLICATIONS

Methods of Measuring Aircraft Performances, by H. T. Tizard 1/6
The Screw Propeller in Air, by M. A. S. Riach 2/6
The High Tension Magneto, by A. P. Young 5/-
Commercial Aeronautics, by G. Holt Thomas 2/6
Steel Tubes for Aircraft, by W. W. and A. G. Hackett 2/6
Design of Aeroplane Struts, by W. H. Barling and H. A. Webb 2/6
Stress Optical Experiments, by A. R. Low 5/-
Struts of Conical Taper, by H. A. Webb and E. D. Lang 1/6
Valve Steels, by P. B. Henshaw 10/-
The Generation of Vortices in Fluids of Small Viscosity, by L. Prandtl 5/-
Consolidated Subject Index (1897-1926) to the Journal of the Royal Aeronautical Society 2/6
Flight of Seagulls, by E. H. Hankin 2/-
Chronology of Aviation, by H. Maxim and W. T. Hammer 1/-
Report of the Bird Construction Committee 10/6
London-Paris Service, Safety and Economy Committee's Report 1/6
The Report of the International Air Congress, London, 1923 ... ... 25/-

Complete list on application

THE ROYAL AERONAUTICAL SOCIETY

(with which is incorporated "The Institution of Aeronautical Engineers"),

7, ALBEMARLE STREET, LONDON, W.1

THOMAS MEADOWS & CO., LTD.

Established 1836.

GENERAL SHIPPING & INSURANCE AGENTS, EXPORT PACKERS, PASSENGER AGENTS.

LONDON:
35, Milk Street, Cheapside, E.C.2.
Telegrams: "MEADOWS, CENT."
Telephone: CITY 3220 (5 lines).

LIVERPOOL:
22, Water Street.
Telegrams: "MEADOWS."
Telephone: CENTRAL 534.

MANCHESTER:
196, Deansgate.
Telegrams: "MEADOWS."
Telephone: CITY 8290.

SOUTHAMPTON:
14, Canute Road.
Telegrams: "MEADOWS."
Telephone: SOUTHAMPTON 2958.

GLASGOW:
45, West Nile Street.
Telegrams: "MEADOWS."
Telephone: CENTRAL 8776.

BRADFORD:
1, Commercial Street.
Telegrams: "MEADOWS."
Telephone: BRADFORD 824.

BIRMINGHAM:
111, New Street.
Telegrams: "SWODAEM."
Telephone: MIDLAND 3339.

LEICESTER:
39, London Road.
Telegrams: "MEADOWS."
Telephone: 20956.

40% lighter than aluminium!

ELEKTRON MAGNESIUM ALLOYS.

Elektron Metal is the Lightest Commercial Metal. Specific Gravity 1.82. Weight per cub. inch 0.065 lbs., about 40% lighter than Aluminium.

Manufactured by I. G. Farbenindustrie, Aktiengesellschaft, Frankfurt A. Main, Germany.

The Alloys are available in following forms:—

Castings	Forgings
Sand Cast	Pressings
Chill Cast	Tubes
Die Cast	Profiles
Extrusions	Angles
Rods	Channels
Bars	Stampings
Strips	Sheets

ELEKTRON METALL **ELEKTRON** ELEKTRON METALL

In the form of Castings Elektron has mechanical properties equal to normal Aluminium Alloys and is 35 to 42% lighter.
Elektron in the form of Bars, Forgings, Sheets, etc., has mechanical properties similar to Wrought Aluminium Alloys of the Duralumin type and is 36 to 38% lighter.
The free cutting and machining of "Elektron" is remarkable.
CASTINGS supplied by **Messrs. STERLING METALS, Ltd., COVENTRY.**

Full information and particulars from :—

Sole Concessionaires for Gt. Britain

F. A. HUGHES & COMPANY, LIMITED.

204/6, Great Portland Street, London, W.1.

Telephone: MUSEUM 8630 (4 lines). Telegrams: DISTANCING, WESDO, LONDON.

Blackburn
NILE
Three 490 h.p. Jupiter IX. engines. Overall
length 68'7" Span 100'. Cabin 16' long 8'5" to
6'3" wide. Accommodation for 14-21 passengers.
THE BLACKBURN AEROPLANE
AND MOTOR COMPANY LIMITED
Head Office and Works: BROUGH, EAST YORKSHIRE
London Office: AMBERLEY HOUSE, NORFOLK STREET,
STRAND, W.C.2
Autocar Auctions

THE JOURNAL
OF
"THE ROYAL AERONAUTICAL SOCIETY"
With which is Incorporated "The Institution of Aeronautical Engineers"

CONTENTS FOR DECEMBER, 1929

PAGE

1 PROCEEDINGS TWELFTH MEETING, SECOND HALF, 64TH SESSION:—
"THE LUBRICATION OF AIRCRAFT ENGINES," BY F. A. FOORD, A.F.R.AES. ... 1089

2 WILBUR WRIGHT MEMORIAL LECTURE:—
"SCIENCE IN RELATION TO REGULATING AND PROMOTING CIVIL AVIATION," BY THE HON. WILLIAM P. MACCRACKEN 1133

3 SUMMARY OF THE SOCIETY'S ACTIVITIES: JANUARY—DECEMBER, 1929 1167

4 REVIEW 1194

THE JOURNAL OF THE ROYAL AERONAUTICAL SOCIETY was *founded in 1897 in succession to the* ANNUAL REPORTS.

For the opinions expressed in Papers that are signed or initialled the authors alone are responsible. None of the Papers or paragraphs must be taken as expressing the opinion of the Council of the Royal Aeronautical Society, unless such is definitely stated to be the case.

The Journal is published monthly at the Offices of the Society, 7, Albemarle Street, Piccadilly, London, W.1.

Telephone: Gerrard 7373. Telegraphic Address: "Didaskalos, Piccy, London."

Subscription per annum, £2 - 4 - 6 post free; Single Numbers 3/6, or 3/9 post free.

All communications for publication in the Journal, or on general matters affecting the Society should be addressed to—

The Secretary and Editor,
J. Laurence Pritchard,
7, Albemarle Street, W.1.

All communications respecting Advertisement matters should be addressed to—
The Advertising Managers, T. G. Scott & Son, Ltd., 63, Ludgate Hill, London, E.C.4.

AIRCRAFT INSTRUMENT MANUFACTURE and REPAIR

is a highly specialised industry, in which it is essential that craftsmanship and science should be allied, if the extreme limits of accuracy demanded by the Air Ministry—in the interest of human safety—are to be obtained.

We only employ specialists; and our Works are equipped with the most modern plant, machinery and scientific Test Apparatus.

This enables us to turn out first class work, at reasonable cost, and to guarantee our deliveries to time specified.

REPAIRS carried out, to Air Ministry Specification, to any make or type of Aircraft instrument—promptly and at a very reasonable cost.

THE ACCURATE RECORDING INSTRUMENT CO., LTD.,
MANOR ROAD :: TEDDINGTON :: MIDDLESEX.

Telegrams: "ACCURACY TEDDINGTON."

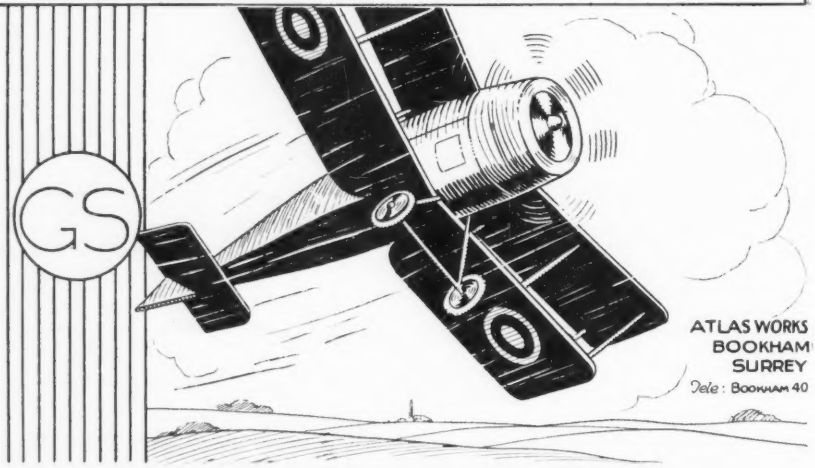
On H.M. Air Ministry List of Contractors, and also of the principal British Aircraft Manufacturing Companies.

Telephone: KINGSTON 6264-5.

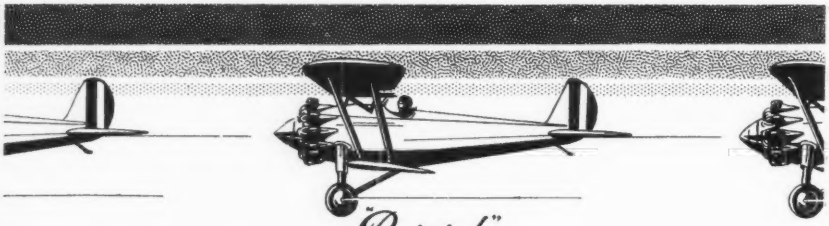
AERO ENGINE MANUFACTURERS
APPROVED BY THE AIR MINISTRY

GILLETT, STEPHEN & CO LTD.

PRECISION MACHINING GRINDING | AUTOMATIC REPETITION WORK | HEAT TREATMENT ENAMELLING | ELECTRO PLATING COPPER DEPOSITING



ATLAS WORKS
BOOKHAM
SURREY
Tele: Bookham 40



"Bristol"

BULLDOG

SINGLE-SEATER FIGHTER,

CONSTRUCTED OF HIGH TENSILE STEEL,

FOR DAY AND NIGHT MILITARY OPERATIONS AT HIGH ALTITUDES HAS TAKEN THE FOREMOST PLACE AMONG THE WORLD'S HIGH PERFORMANCE MILITARY AIRCRAFT. THE SIMPLICITY AND EXCELLENCE OF THE DESIGN, TOGETHER WITH EXCEPTIONAL PERFORMANCE, MARKS THE MACHINE AS THE MOST EFFICIENT SINGLE-SEATER FIGHTER OF THE PRESENT DAY. THE BULLDOG IS DESIGNED AND CONSTRUCTED BY

THE BRISTOL AEROPLANE CO., LTD., FILTON, BRISTOL.

FAIREY
AIRCRAFT
THE · FAIREY · AVIATION · COMPANY · LTD · HAYES · MIDDLESEX

STAINLESS STEEL & IRON

BBSW STAINLESS
Trade Mark

Made by the Inventor at

BROWN BAYLEY'S STEEL WORKS Ltd.

SHEFFIELD.

VICKERS STEELS SUCCEED AGAIN!

SCHNEIDER TROPHY CONTEST—Average Speed 328.6 m.p.h. ∴ WORLD'S SPEED RECORD—357.7 m.p.h.

VICKERS STEELS were used in the important parts of the Rolls-Royce Engine of the Supermarine S, 6, such as:—
CRANKSHAFT, PROPELLER SHAFT, PROPELLER HUB, PROPELLER HUB FLANGE and ROCKER SHAFT TUBE.

ENGLISH STEEL CORPORATION LIMITED

Incorporating the Steel and Allied Businesses formerly carried on by
VICKERS-ARMSTRONGS LTD., AT SHEFFIELD & OPENSHAW. CAMMELL, LAIRD & CO. LTD., AT SHEFFIELD & PENISTONE.

VICKERS WORKS, SHEFFIELD, ENGLAND.

ESC SHEFFIELD VICKERS

London Office: VICKERS HOUSE, BROADWAY, S.W.1.

JOHN MARSTON, LTD.,

Paul Street Works, WOLVERHAMPTON.

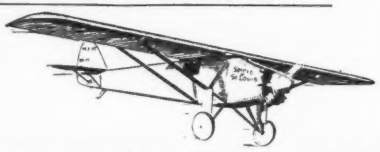
Manufacturers of Radiators & Tanks for Aircraft.

On Air Ministry A.I.D. Approved List.

'Phone: 1481 Wolverhampton.

SWISS METAL WORKS.

SELVE & Co.,



THUN
(SWITZERLAND).

ACCURATELY BRIGHT DRAWN BRASS AND BRONZE RODS
FOR
PHYSICAL INSTRUMENTS, Etc., Etc.

Agents for Great Britain:
E. A. HERBERT & CO., Ltd., 35, SUMMER HILL STREET, BIRMINGHAM.
E. A. HERBERT & CO., Ltd., 104, HIGH HOLBORN, LONDON, W.C.1.

Telegrams: INDUS, Sheffield. Telephones: 41043-8 Attercliffe.

INDUSTRIAL STEELS Ltd.

SHEFFIELD.

HIGH-GRADE ALLOY STEELS

FOR

Automobile & Aero Engine Construction

IN

BILLETS, BLOOMS, SLABS or BARS

INCLUDING

CASE HARDENING STEELS
NICKEL CHROME STEELS
CHROME STEELS
CHROME VANADIUM STEELS
NICKEL CHROME MOLYBDENUM
SILICO MANGANESE and SILICO CHROME SPRING STEELS.
VALVE STEELS, etc., etc. DIE BLOCKS.

Write for our High-grade Steel Booklet.

Tool Steels for all purposes.

INDUS

Branches: London, Manchester, Glasgow, Newcastle-on-Tyne, Leeds, Nottingham

Dunelt

SPECIAL STEELS for AIRCRAFT

Conforming to all the Air Board and E.S.C. Specifications.

CASE HARDENING STEELS.

MEDIUM CARBON STEELS.

HIGH TENSILE ALLOY STEELS.

Dunford & Elliott (Sheffield Ltd.)

Attercliffe Wharf Works, Sheffield.

Telegrams: "Blooms, Sheffield." Telephone: Attercliffe 41121.
London Office: Finsbury Pavement House, Moorgate, E.C.2.
Birmingham Office: 96, Bath Street.
Manchester Office: 26, Corporation Street.

The supremacy of Sterling — pioneers of electrical insulating varnish—is due to years of intensive research and world-wide experience.

For every insulating purpose specify

Sterling INSULATING VARNISH

Not associated with any ring, trust or combine.

The

STERLING VARNISH COMPANY

Fraser Road, Trafford Park,

MANCHESTER.

LIGHT STEEL CASTINGS

made from the high frequency Electric Furnace, in

PLAIN CARBON STEEL

"FIRTH'S STAYBRITE"
(RE-MELTED)
and
COBALT STEEL
for Magnets.

Lake & Elliot, Ltd.
BRAINTREE · ESSEX

ENGINEERS AND STEEL FOUNDERS.

'PHONE : W'HAMPTON 1386.
LONDON HOLBORN 8829.

'GRAMS : SOARING, W'HAMPTON

SPRING WASHERS Ltd.

Eagle Works,
: Alexandra Street :
WOLVERHAMPTON

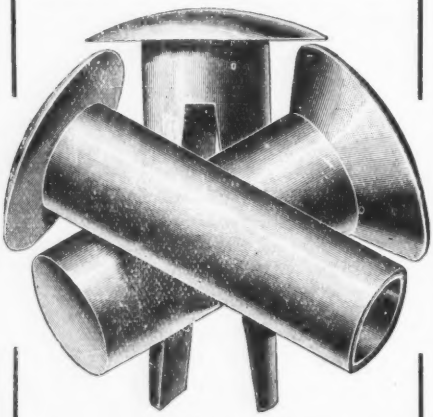
Manufacturers of
SINGLE COIL, SQUARE, FLAT and GIRDER SECTION SPRING WASHERS also DOUBLE COIL THACKERAY TYPE IN STEEL, BRASS, PHOSPHOR BRONZE, PLATED or STAYBRIGHT.

Fully Approved on A.I.D. List.

London Office:—
Fairfax House, High Holborn, London, W.C.1.

"Aylesbury Brand" Rivets

In coppered, brassed, nickeled or japanned, and in brass, copper, aluminium, steel, etc.

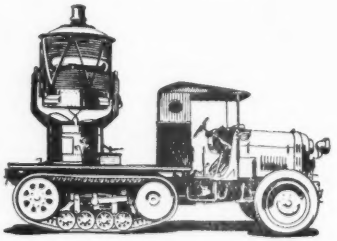


Manufactured by
THE BIFURCATED & TUBULAR RIVET CO. LTD.
Inquiries Invited. **Works: Aylesbury, Bucks.**

AERODROME LIGHTS

INCLUDING

MOBILE COMBINED, BEACON and FLOOD, EMERGENCY, SIGNALLING, NAVIGATION, HIGH INTENSITY.



Also REPAIRS, SPARE LENSES, CARBONS, MIRRORS, Etc.

THE LONDON ELECTRIC FIRM CROYDON.

Telephone— Purley 1222, 1223.
Telegrams— "Electric, Phone, Croydon."

THE NATIONAL RESEARCH COUNCIL OF CANADA

will shortly appoint to its technical staff two junior researchers whose aptitude and experience are along lines of research in (1) Heat, (2) Aeronautics.

These researchers will be required to give immediate attention to problems dealing with (1) Conduction and Insulation of Heat, (2) Aerodynamics, Hydrodynamics and Aircraft Engines.

Interested applicants should communicate immediately, stating age, education, research experience, references and salary required to **S. P. Eagleson, Esq., Secretary, National Research Council of Canada, Ottawa, Canada.**

FOR A SAFE EXAM.-PASS ENROL WITH THE T.I.G.B.

In pursuance of its policy of furnishing the highest standard of training The T.I.G.B. has submitted its correspondence coaching courses for the Examinations of

The Royal Aeronautical Society

to the Secretary of the Society who has scrutinized the courses and will be glad to advise any candidate for the Society's examinations as to the efficiency and suitability of T.I.G.B. correspondence training.

The T.I.G.B. courses present the knowledge and experience of a most highly qualified tutorial staff and practically assure a safe exam.-pass at the first attempt. **The T.I.G.B. guarantees training until successful.**

FREE—This 124-Page Book

Get "The Engineer's Guide to Success," containing the widest selection of engineering courses in the world, and investigate the remarkably successful Tuition Methods of The T.I.G.B. Write to-day for copy and state your tuition requirements, to

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN

(Established 1917)

250, TEMPLE BAR HOUSE, LONDON, E.C.4.

ELECTRICAL INSTRUMENTS for AIRCRAFT

MANUFACTURED BY

ERNEST TURNER

HIGH WYCOMBE,
BUCKS, ENGLAND.

Contractor to British Air Ministry, Post Office, Radio Companies, Etc.

AIR MINISTRY APPROVED FIRM

Over 90% of Electrical Instruments in British Airplanes and Equipment for Aircraft, shown at Aero Exhibition, 1929, were of Turner Manufacture.

SPECIAL INSTRUMENTS FOR GROUND TESTING AND ——LABORATORY USE.——

Catalogues on Request.

Phone: High Wycombe 301. **Telegrams: Gorgeous, High Wycombe.**

Aeronautical Publications.

CONSOLIDATED SUBJECT INDEX TO THE JOURNAL OF THE ROYAL AERONAUTICAL SOCIETY.

This is a complete full index of all articles and papers, etc., which have appeared in the Journal for 1897-1926 inclusive.

Price 2s. 6d. net.

CATALOGUE OF THE LIBRARY OF THE ROYAL AERONAUTICAL SOCIETY.

A Subject and Authors' Index of the most comprehensive Aeronautical Library in the world.

Price 5s. 0d.

ANNUAL REPORTS OF THE AERONAUTICAL SOCIETY.

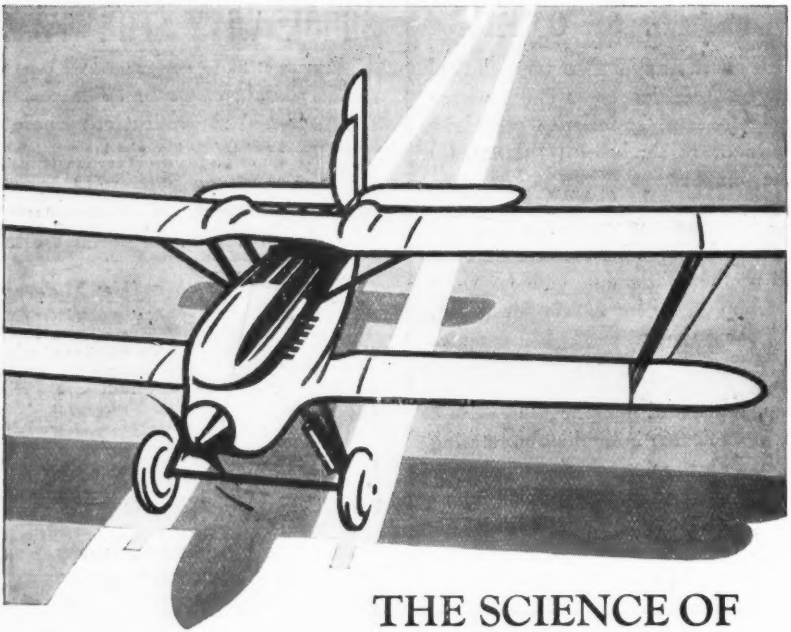
These Reports issued annually from 1866-1897, form a complete record of the pioneer work that was done during that period, and are of great historical interest and value. As many of these volumes are now extremely rare, special prices will be forwarded on application.

THE ROYAL AERONAUTICAL SOCIETY,

with which is incorporated "The Institution of Aeronautical Engineers"

7, ALBEMARLE STREET, LONDON, W.1

Secretary and Editor:
J. LAURENCE PRITCHARD.



THE SCIENCE OF LANDING

is the Pilot's job, but between skill and performance lies an even greater science—that which is built into the Dunlop wheel and tyre. The combination of Dunlop Aeroplane tyres and the new Dunlop Patent Disc Wheel provides the perfect unit.

Safe landing on

DUNLOP

DUNLOP RUBBER CO. LIMITED,
FORT DUNLOP :: BIRMINGHAM.
Branches throughout the World.

C.F.H. 1094